



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

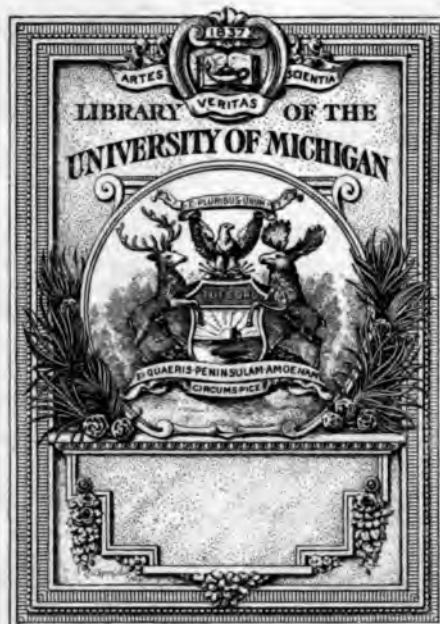
We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

B 1,034,446



21A
24
A15

ANNUAL REPORTS

OF THE

119703

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1902.

SUPPLEMENT

TO THE

REPORT OF THE CHIEF OF ENGINEERS.

REPORTS OF THE MISSISSIPPI RIVER COMMISSION
AND MISSOURI RIVER COMMISSION.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

**ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE
FISCAL YEAR ENDING JUNE 30, 1902.**

ST. LOUIS, MO., *June 30, 1902.*

SIR: The Mississippi River Commission has the honor to submit this annual report for the fiscal year ending June 30, 1902.

The river and harbor bill having failed to pass during the session of Congress of 1900-1901, no appropriation has been made for the improvement of the Mississippi River since the sundry civil bill of June 6, 1900, until the passage of the act approved June 13, 1902.

At the beginning of this fiscal year, July 1, 1901, the balances available, in the hands of the Commission, were as follows:

Mississippi River Commission	\$23, 750. 55
Surveys, gauges, and observations	47, 953. 75
Levees	223, 130. 45
Revetment and construction work, permanent channel improvements and protection	53, 924. 65
Dredges and dredging	322, 163. 63
Plant and miscellaneous	38, 223. 68
Improving harbors and tributaries	194, 583. 24
Works above Cairo	2, 571. 70
Reserved in hands of the president	68, 000. 00
	<hr/>
	974, 301. 61

During the past fiscal year the following allotments and transfers of allotments have been made:

ALLOTMENTS.

From reserve in the hands of the president, to Lake Providence reach	\$25, 000
(Approved October 16, 1901.)	
From reserve in the hands of the president, to surveys, gauges, and observations	6, 500
(Approved December 2, 1901.)	

TRANSFERS OF ALLOTMENTS.

From Lower Yazoo levee district	\$32, 000
From Upper Tensas levee district	8, 000
	<hr/>
	40, 000
	<hr/>
To Lake Providence reach	25, 000
To plant, third district	15, 000
	<hr/>
	40, 000
	<hr/>
(Approved, November 18, 1901.)	
From dredges and dredging to Mississippi River Commission	5, 000
(Approved, February 14, 1902.)	
From dredges and dredging to office Chief of Engineers	5, 000

This last transfer of allotment, approved February 25, 1902, was made under the legislative, executive, and judicial act.

MEETINGS.

During the fiscal year the Commission has held three sessions, as follows:

Eighty-fourth session, from November 7 to 17, 1901, in St. Louis and on the steamer *Mississippi*, for the transaction of general business and for inspection purposes.

Eighty-fifth session, from April 2 to 8, 1902, in St. Louis and on the steamer *Mississippi*, for the transaction of general business and inspection purposes.

Eighty-sixth session, from June 23 to 26, 1902, in St. Louis, for the consideration of allotments and future operations under the river and harbor bill of June 13, 1902, and the preparation of the annual report.

At each of these meetings hearings were given to and conferences held with the representatives of navigation, commercial, and agricultural interests on the river.

During the year the membership of the Commission has been changed by the relief of Lieut. Col. T. H. Handbury, Corps of Engineers, U. S. A., and the appointment of Maj. T. L. Casey, Corps of Engineers, U. S. Army.

Capt. G. P. Howell, Corps of Engineers, U. S. Army, on August 12, 1901, relieved Capt. M. M. Patrick, Corps of Engineers, U. S. Army, as secretary of the Commission.

MISSISSIPPI RIVER COMMISSION.

Capt. G. P. Howell, Corps of Engineers, U. S. Army, secretary. Office, Fullerton Building, Pine and Seventh streets, St. Louis, Mo.

The duties of this office are as follows:

First. The recording and publication of the transactions of the Commission.

Second. The conduct of the survey of the Mississippi River, ordered by Congress, from its headwaters to the Head of the Passes, and the mapping and publication of its results.

Third. The surveys, gaugings, and observations, and computations connected with them, necessary for the study of the physics of the river and for keeping the Commission informed of such changes as occur.

Fourth. The operation of the dredges during low water, and the care, preservation, and repair of the dredging fleet when out of commission, and of the survey fleet, and the designing and construction of new dredges.

Fifth. Such other work as may from time to time be required by resolution of the Commission.

These duties are referred to in detail:

1. This office has issued during the year printed proceedings of all meetings of the Commission, monthly reports by the secretary and district officers, monthly hydrographs, special reports of surveys and examinations, annual gauge records, and other papers relating to the works of the Commission.

2. Owing to the failure of appropriation at the session of Congress of 1900-1901, but little extension of the survey of the river has been made during the past year and no new charts have been published. The topography and hydrography now extends from the Head of the

Passes to Aitkin, Minn. Progress has been made with the survey of Lake Itasca and its vicinity. The stretch of river between these two points still awaits the survey necessary to complete the entire work.

Exact leveling is completed from the mouths of South and South-west Passes to Lake Itasca, and branch lines connect it with the Gulf of Mexico at Biloxi, Miss., with Lake Michigan at Chicago, and with Lake Superior at Duluth. Releveling parts of the line along the lower river has shown discrepancies which indicate a geological disturbance along the shore of the Gulf of Mexico. The interesting question thus raised makes it highly important that the line below the older formations on the river bank which give relative assurance of the stability of the earth's surface should be rerun at proper intervals, and that the tide gauges at East Bay and Biloxi should be continued and carefully maintained.

Reduction, platting, and mapping have been continued in the office. The following charts have been published and are now available for distribution:

Alluvial valley of the Mississippi River from Cairo to the Gulf of Mexico, in 8 sheets; scale, 1 inch to 5 miles, 1887 and 1899.

Valley of the Mississippi River from Cairo to St. Paul, in 4 sheets; scale, 1 inch to 5 miles; 1899.

District map of the Mississippi River from Cairo to the Gulf of Mexico, showing improvement and levee districts, in 1 sheet; scale, 1 inch to 5 miles; 1897.

Detail charts, showing hydrography and adjacent topography of the river from the Head of the Passes to Newport, Minn., 1,926 miles, in 170 sheets; scale, 1: 20,000.

Map of the Mississippi River from the Head of the Passes to Trempealeau, Wis., in 62 sheets; scale, 1 inch to 1 mile.

At the request of the Commission, the War Department has, by a recent ruling, authorized the free issuance of any of these charts, upon application to the secretary of the Commission, to heads of departments, members of Congress, Government officials in the performance of whose duties they may be beneficial, educational institutions, public libraries, individuals or organized bodies interested in the study of physical data, the development of navigation, or in any work carried on by the Commission, and to engineers engaged in the prosecution or study of works of hydraulic engineering. The 1 inch to 1 mile charts may also be issued on the application of any person controlling a boat for that part of the river to which its route is limited.

3. The surveys, gaugings, and observations made the duty of this office have been continued during the year, including the inspection, repair, and daily recording of 38 gauges on the Mississippi River and its tributaries; the observation of extreme high-water readings on a series of 182 gauges, about 5 miles apart and extending from Cairo to Fort Jackson; the establishment of high and low water slopes, and the measurement of discharge at fixed points on the Mississippi River and its principal tributaries whenever certain stages of high and low water are exceeded. As the last river year has not been marked by extreme stages, this last duty has only been required at Rockcastle, Ky., on the Cumberland, during high, and at Columbus, Ky., Helena and Arkansas City, Ark., during low, water.

During the year a temporary gauge, in connection with the survey, has been established at Aitkin, Minn.

4. Since the inauguration of hydraulic dredging on the Mississippi River below Cairo for the improvement of its low-water navigation, in 1896, the Commission has built 9 dredges. The first, *Alpha*, was designed experimentally by a committee of the Commission consisting of Col. Henry Flad and Col. C. R. Suter. The success of this dredge boat led to an extended application of the project. Following the *Alpha* the next boats were built on the designs of contractors. With the experience gained in operation and repair the later dredges have been built on detailed plans and specifications prepared in the office of the Commission. Many modifications and improvements have been introduced in the direction of simplification, strength, and regularity of service. The last three dredges, *Iota*, *Kappa*, and *Henry Flad*, have been made self-propelling by side wheels. This makes them more manageable during operation, dispenses with the service of a pile sinker and tender, reduces the number of the crew, and allows other conveniences and economies. The security and flexibility of the discharge pipes have been greatly increased. By this latter feature, combined with an improved steering apparatus, the pipes can now be so deflected from the line of the dredged channel that only about 500 instead of 1,000 feet will be required, thus giving a great increase in the output of the pumps.

About 15 per cent of the time of actual operation has heretofore been consumed in changing cuts or dropping the dredge back to the lower side of the bar to start up in a new cut. During this time the pumps are idle. To obviate this loss a suction head has been devised and is now being applied, with which the pumps can operate while the boat is dropping down as well as while working up stream. Experiments are also being made with the intention of replacing the piles now used as anchorages for the motor lines with mushroom anchors. In either case the sinking will be done hydraulically.

Heretofore the Commission has used, on its several dredges, pumps of various types, each apparently recommended by different features. It is now the intention to institute a series of comparative tests, in order that a standard type of pump, combining in the greatest degree efficiency, endurance, and convenience, may be adopted in future dredges. It is strange that in the great application of centrifugal pumps to different uses in recent years no conclusive experiments of this character have yet been made.

Of the nine dredges built by the Commission eight are now in service. The *Alpha*, the only one with a wooden hull, has been dismantled. It was the intention of the Commission to reinstall her machinery in a new hull for service on the lower reaches of the river, as the limited and insufficient number of dredges has only allowed operations on the bars from Cairo to Peters Towhead, about 270 miles below. Of the eight mentioned seven were in commission during the low-water season, between the months of August and November, inclusive. Eighteen different locations required more or less dredging, which fully employed the service of six dredges. The output is estimated at one and two-thirds million cubic yards. The seventh, the *Gamma*, was used to assist in the bank protection at Lake Providence by directing the flow, thus reducing the energy of the attack of the current on the caving bank. This new application of dredging proved, to a considerable degree, successful, and it is thought by the Commission that hereafter it may be advantageously used in river improvements of this character.

During the low-water season there was maintained a depth of 10 feet through all bars from Cairo as far down as the number of the fleet allowed work to be done, with the exception of $9\frac{1}{2}$ feet at Hatchie crossing, from August 2 to 16, and at Presidents Island, from August 9 to 11. At the time of lowest water, in November (Cairo, 2.9; New Madrid, 3.4; and Memphis, -0.3), there was 10 feet of water through to Peters Towhead, 270 miles, where the lowest dredging was done. Special reference is made in this connection to the plates accompanying the secretary's report, numbered from 4 to 65.

The continued success and development of the project of securing a low-water channel of satisfactory dimensions on the Mississippi River below Cairo, by hydraulic dredging, depends on the maintenance of a sufficient fleet, in good order, in charge of engineers experienced in the physics of the river and guided by frequent and exact surveys.

During the year the care and preservation of the dredging and surveying plant has been satisfactorily attended to.

In view of the facts that the bar obstructions to low-water navigation during the last season were not unusually serious or prolonged; that the number of dredges in the present fleet is not sufficient to render service over more than one-half of the length of river between Cairo and Vicksburg, in any part of which shoal water is liable to occur in any season; that both the present standard depth (9 feet) and width (250 feet) of low-water channel can be increased to advantage, and that new and useful applications of dredging are probable in the near future, the Commission is of the opinion that an increase in the number and capacity of dredges should receive consideration at this time.

5. Among the other duties imposed on this office during the past year have been: (1) The collection of the physical conditions of the St. Francis Basin in such form as will allow a proper study of the project for its use as a storage reservoir to abate the floods from Cairo down and improve low-water navigation below the mouth of the St. Francis River; much progress has been made, and the information will be presented during the year in the form of a contoured map, on the scale of 1 inch to 1 mile. (2) The preparation of statistics of the commerce of the Mississippi River from St. Louis to the Head of Passes in more connected form than has heretofore been done. This information will be found in the appended report of the secretary in the following tables (Appendix 1):

Table 1.—Tonnage between St. Louis and Cairo; tonnage between Cairo and Memphis; tonnage between Memphis and Vicksburg; tonnage between Vicksburg and New Orleans.

Table 2.—Receipts and shipments at St. Louis, Memphis, Vicksburg, and New Orleans.

Table 3.—Seagoing traffic of New Orleans.

At the same time, as a matter of interest, although not forming part of the commerce of the river, the amount of ferry transport across the river at 13 different points is collected in a separate table, No. 4.

In the report of the secretary is a statement of items necessary to the completion of these statistics, which it has been, so far, impossible to obtain.

For full information on the subjects herein summarized reference is made to the reports of Capt. G. P. Howell, Corps of Engineers, U. S. Army, secretary of the Mississippi River Commission, and of

C. W. Sturtevant, F. B. Maltby, and K. Tully, assistant engineers in his office. (Appendix 1.)

CHANNEL WORKS, BANK PROTECTION, AND HARBOR IMPROVEMENTS IN
THE SEVERAL DISTRICTS.

Owing to the failure of appropriations since the sundry civil bill of 1900, work in these districts has been restricted to such repairs of existing work as were possible, with existing balances, and to the care and preservation of plant.

Works above Cairo.—Maj. T. L. Casey, Corps of Engineers, U. S. Army, in charge. Office, custom-house, St. Louis, Mo. No extension or repair has been made during the year to the revetment built to arrest the erosion on the left bank of the Mississippi River in rear of Cairo. No additional work is now necessary.

First district, from Cairo to the foot of Island 40, 220 miles.—Capt. E. E. Winslow, Corps of Engineers, U. S. Army, in charge. Office, 280 Second street, Memphis, Tenn. In this district are included the improvement of the harbors of Columbus and Hickman, Ky., New Madrid and Caruthersville, Mo., the improvement of Plum Point Reach, and certain experimental dikes for low water navigation.

Harbor of Columbus, Ky., 21 miles below Cairo.—This work, commenced in 1889 and finished in 1890, remains in the same condition of completion and good order as was described in the last annual report of the Commission.

Harbor of Hickman, Ky., 36 miles below Cairo.—This work, constructed between the years 1889 to 1894, remains in the same completeness and good order as was described in the last annual report.

Harbor of New Madrid, Mo., 71 miles below Cairo.—This work was constructed between the years 1893 and 1899, and consists of a revetment extending from the mouth of Bayou St. John down past the city front, 4,500 feet in length. It remains in the same condition of completeness and good order described in the last annual report.

Harbor of Caruthersville, Mo., 110 miles below Cairo.—This work was constructed in 1898 and 1899, and consists of a revetment 1,890 feet long. It is complete and in good order for this length, with the exception of the bank paving, which should be carried up the slope to or near the top of the bank. It is also advisable that the revetment be extended farther down stream.

The four harbor improvements, heretofore described, have been objects of special appropriation.

Plum Point Reach, Tennessee and Arkansas, 147 to 186 miles below Cairo.—The work for the improvement of this reach consists of bank revetment and channel contraction, and extends from Daniels Point, Arkansas, near its head, about 20 miles down, to the vicinity of Craighead Point, Arkansas. The funds available during the past year have not been sufficient to make the necessary repairs or prevent the extension of the damage previously reported to Congress as occurring at Daniels Point, Fletchers Bend, Osceola Bar, Gold Dust chute, and other localities of less importance.

Experimental dikes.—Such of these dikes as have been constructed in favorable locations, and at stages of water suitable to their action, have secured results which will justify, to a certain extent, their future use as an auxiliary method of securing low-water improvement.

Reference is made for full information concerning the transactions of the Commission in this district, summarized above, to the reports of Capt. E. E. Winslow, Corps of Engineers, U. S. Army, in charge, and of Messrs. A. J. Noltz and W. M. Rees, assistant engineers. (Appendix 2.)

Second district, from the foot of Island 40 to the mouth of White River, 175 miles.—Capt. E. E. Winslow, Corps of Engineers, U. S. Army, in charge. Office, 280 Second street, Memphis, Tenn.

In this district are comprised the improvement of the harbor of Memphis, including the revetment of Hopefield Bend and the annual dredging of Wolf River, and also the protection of the harbor of Helena, Ark.

Memphis Harbor, Tennessee, 230 miles below Cairo.—The protection of the river front of the city of Memphis from the old mouth of Wolf River to a point below the bridge has been jointly accomplished by special Government appropriation for Memphis Harbor, by allotments by the Commission from appropriations for the general improvement of the river, and by funds supplied by the citizens of Memphis and the bridge company. This entire work is now in good condition. The bar which encroached on the upper end of the harbor front as the result of the recession of Hopefield Point, during a period when its protection was impossible from the absence of appropriation, shows no sign of farther advance. It is the opinion of the Commission that this bar front should be accepted as a new part of the Memphis Harbor line, and that future efforts should be directed to its reclamation and improvement by parties interested.

Such repair to the revetment of Hopefield Bend as was absolutely necessary has been made during the past year, and it is now in good condition. The preservation of the harbor facilities of Memphis is so entirely dependent upon the maintenance of this work that the Commission is of the opinion that it should be the object of regular special appropriations as a part of Memphis Harbor.

Wolf River, a tributary, joining the Mississippi within the city limits of Memphis, is an important feeder to large lumber, railroad, and manufacturing interests. It is probable that the best practicable method of improvement is by annual dredging. For this purpose special appropriations have been made by Congress in recent years. The execution of the project during the past year has been satisfactory. It is advisable that suitable appropriations be continued.

Harbor of Helena, Ark., 306 miles below Cairo.—The protection of this harbor has been under special appropriations. It consists of a combination of spur and revetment work, with an aggregate length of 4,900 feet, covering the improved front of the city. It is now in good order, with the exception of the settlement of a short length of bank. This condition makes the continuance of a repair fund advisable.

In the appended report of Capt. E. E. Winslow, Corps of Engineers, U. S. Army, in charge, and of Assistant Engineer W. M. Rees, full details of the conditions and operations in this district will be found. (Appendix 2.)

Third district, from the mouth of White River to Warrenton, Miss., 214 miles.—Capt. C. L. Potter, Corps of Engineers, U. S. Army, in charge. Office, Randolph Building, Memphis, Tenn.

In this district are included the works of improvement at the upper end of Lake Bolivar, Miss.; Ashbrook Neck, Miss.; Greenville Har-

bor, Miss.; Lake Providence, La., and Delta Point, La., opposite Vicksburg.

As in the other two districts, work in this has been restricted, by the failure of appropriations, to such repairs as were necessary to prevent serious loss. In two instances, Lake Providence revetment and the care and preservation of plant, the loss would have been irreparable, and it became necessary to make transfer of sufficient funds for these purposes from the reserve for emergencies in the president's hands and from the levee allotments.

Lake Bolivar, Miss., 417 miles below Cairo.—The revetment at the upper end of this lake was built under special appropriation in 1888–89, with the object of maintaining the levee line in front of the lake, thus saving very extensive levee construction and the abandonment of a large and highly valuable area. It is now in good order. A similar emergency has now arisen at the lower end of the lake. The caving bank has there approached the levee at a point where it will be difficult to retire it on account of the proximity of the bed of the Old River.

Ashbrook Neck, Mississippi, 446 miles below Cairo.—A revetment of about 10,000 feet in length was built on the upper side of this neck, where it was only 2,000 feet wide and about 12 miles around the point, in the years from 1890 to 1895. Extensive repairs have subsequently been made. The object of the work is the prevention of a cut-off, which in this locality would have peculiarly disastrous results, including cut-offs in the two adjacent bends, the destruction of Greenville Harbor, and the loss of a considerable part of the levee line. The prevention of such cut-offs is a well-defined part of the policy of the Commission.

Greenville Harbor, Mississippi, 478 miles below Cairo.—The protection of this city and its harbor from caving was commenced, by special appropriation, in 1887, and has been so continued until a sufficient extension, 14,500 feet, was given in 1895. The lower and earlier work was constructed with spurs, but in 1891 a change was made to revetment. Frequent repairs have been made, and others are now necessary.

Lake Providence Reach, 517 to 552 miles below Cairo.—The earlier works on this reach have had a decidedly beneficial effect on the channel which still persists, but as the type of construction used in the earlier years was much lighter than that now employed, many repairs have been necessary, and parts of the work have been abandoned.

The revetment at and above the town of Lake Providence has been vigorously pushed and maintained since 1894, until it now has a length of 12,800 feet in good order. This work has special importance from the proximity of the river to the lake. If the present bank line is allowed to recede, a new levee back of the lake will be necessary, at great cost, as well as the abandonment of a large and valuable area of farming land. In connection with this improvement the dredge *Gamma* was successfully used to control the flow in order to relieve the attack of the current on a part of the bank where it was found particularly difficult to place and hold the revetment.

Delta Point, Louisiana, 598 miles below Cairo.—The prevention of the further recession of this point really forms part of the improvement of Vicksburg Harbor, being immediately opposite the mouth of the projected canal from the Yazoo River through the old river lakes. The work in recent years has been done by allotments from the appropria-

tions for the general improvement of the river. This revetment and that of the upper Memphis front, below the old mouth of Wolf River, were the earliest built on the Mississippi, dating back prior to 1880. From age, the insufficiency of original methods, and the flanking action of the caving, both repairs and extensions have been necessary. It is now in good condition, although the caving above, if continuous, will soon require an extension in that direction.

For full information concerning the conditions and operations in this district reference is made to the appended reports of Capt. C. L. Potter, Corps of Engineers, U. S. Army, officer in charge, and of Assistant Engineer Arthur Hider and Superintendent G. C. Thomas. (Appendix 3.)

Fourth district, from Warrenton, Miss., 7½ miles below Vicksburg, to the Head of the Passes, 453 miles.—Maj. George McC. Derby, Corps of Engineers, U. S. Army, in charge. Office, 3232 Prytania street, New Orleans, La.

The works in this district include the improvement of the harbors at Natchez, Miss., and Vidalia, La.; of the junction of Mississippi, Red, and Atchafalaya rivers; of the harbor of New Orleans, and bank protection in Bondurant chute and Kempe bend.

Harbors of Natchez, Miss., and Vidalia, La., 700 miles below Cairo.—The preservation of these harbors is dependent upon the prevention of a cut-off through the narrow neck of Cowpen Point. The project includes a revetment of the caving bank on the upper side of the point to prevent its further recession and the construction of a spur levee from the hills along the axis of the point to prevent the race of water across it. This spur levee has been constructed and is now in good condition. Of the total projected length of bank protection, which is a combination of spur and revetment work, about 12,260 feet has been built and is now in good order. It should be extended to completion at an early date, as the narrowest part of the neck has not yet been covered. Apart from the local importance of these harbors it is highly important that this cut-off, as well as all others, should be prevented in the interest of the general improvement of the river. The work has generally been done under special appropriations and a continuation of these is advised.

Junction of the Mississippi, Red, and Atchafalaya rivers, 76½ miles below Cairo.—Owing to the absence of sufficient appropriations, the project for the improvement of this locality, presented in the annual report of the Commission for 1892, has never been carried out beyond the partial building of the dam at head of Turnbull Island. In the meantime the local conditions have so changed, and the capacity of dredging machinery has been so developed, that important modifications and simplifications have been advised in later reports. The project now includes the prevention of the further enlargement of the Atchafalaya and the maintenance of navigation at all stages, by dredging, through lower Old River. Satisfactory progress has been made in both these departments of the work. It is important that annual information be obtained of any physical changes occurring in the lower Old and Atchafalaya rivers, and that sufficient funds be on hand to arrest any marked enlargement of sections or increase of discharge from the Mississippi. This is especially important in view of the contraction of section caused by the recent construction of embankments leading to the bridge across lower Old River.

New Orleans Harbor, 969 miles below Cairo.—The appended report by Maj. George McC. Derby on the condition of this harbor correctly shows the importance of the rapid extension of work for its protection. This can only be done with more regular and much larger appropriations than have hitherto been made. The Commission knows of no locality on the river where such great interests are in so critical a condition. The Commission has for years past advised the profitable expenditure annually of \$300,000 in the prosecution of the project, while the appropriations have averaged but \$55,000 a year. The recommendation of previous years is urgently repeated in this report.

Bondurant Chute, 644 miles below Cairo.—This work was given the length originally intended during the previous year. It is in good order and serving its purpose. A downstream extension has been rendered necessary at an early day on account of bank caving at the end.

Kempe Bend, 657 miles below Cairo.—The extension of the revetment of this bend is of immediate importance, but no work has been possible during the past year, from want of funds. It was necessary to keep in hand such balance as was left to repair any defect, since for a considerable distance the revetted bank is immediately against the levee, in the rear of which is a most extensive and impracticable swamp.

Full information concerning the condition of and operations in this district will be found in the appended reports of Maj. George McC. Derby, Corps of Engineers, U. S. Army, and of Assistant Engineers H. S. Douglas and L. E. Lion, to which reference is made. (Appendix 4.)

Particular attention is directed to the experimental use now being made of concrete and brick in place of stone, in this district, for sinking mats and upper bank protection.

Owing to the failure of regular appropriations, the Commission reports that no progress in the general improvement of the river has been made during the past year. The balances in its hands have not, in all cases, been sufficient to make the repairs previously reported as necessary to prevent the increase of damage resulting therefrom, or to give proper attention to the care and preservation of plant. The allotment from the present appropriation to make good this deterioration will, therefore, be large. This statement is generally true of the four districts into which the river below Cairo is divided.

LEVEES.

In the First and Second engineer districts, under the charge of Capt. E. E. Winslow, Corps of Engineers, U. S. Army, are included the following levee districts:

Upper St. Francis, right bank, from Birds Point, Mo., opposite Cairo, to New Madrid, 70 miles.

Reelfoot, left bank, from Hickman, Ky., 36 miles below Cairo, to Slough Landing, 24 miles.

Lower St. Francis, right bank, from Point Pleasant, Mo., 79 miles below Cairo, to the mouth of the St. Francis River, 219 miles.

White River, right bank, from Helena, Ark., 306 miles below Cairo, to Laconia Circle, 79 miles.

Upper Yazoo, left bank, from the bluffs, 14 miles below Memphis, to the Coahoma-Bolivar county line, Mississippi, 121 miles.

Upper St. Francis levee district.—The levees undertaken in this

district by the Commission are the continuation of a line already partially built by State and local authorities in Missouri, from Cape Girardeau to Birds Point. They have been extended down about 5½ miles to the vicinity of a natural drain, tributary to the Mississippi. Until provision is made by the local authorities for the proper disposition of this drainage, under plans approved by the Mississippi River Commission, it is inadvisable that further extension be made under allotment of Government funds. No work has been done during the past year either by general or local authority.

Reelfoot levee district.—The levee at the lower end of this district, in Tennessee, has been built by local authorities up to the Kentucky line. No allotment has heretofore been made, as the right of way through Kentucky had not been secured. This has now been done, and it is advisable that an allotment now be made to commence the extension of the levee already built in Tennessee by the local authorities into the State of Kentucky.

Lower St. Francis levee district.—The length of existing levee line in this district is 183 miles. It is not, however, continuous, being interrupted by an unbuilt gap of about 17 miles between an upper section, 166, and a lower, 17 miles long. The work has been done by the cooperation of the General Government and local authorities. The policy of the latter has naturally been to cover as much front as practicable with a levee of moderate dimensions, while the Government allotments have been mainly used in increasing them to a grade and section approximate to that considered as finally necessary. A downstream extension of about 10 miles is contemplated to complete the system.

The general grade of the levees built in this district is within 3 or 4 feet of that established by the Commission, but much banquette work is required for the standard section. In several places the line is so threatened by caving banks that new loops must be built in a few years. During the year the United States has built 73,476 and the State authorities 758,490 cubic yards.

White River levee district.—Of a total length of line of 74 miles, the United States has worked on 64, the other 10 miles being under private control. The levees of the district are generally low in grade and weak in section. There are also four breaks, grouped in the same neighborhood, aggregating about 10,000 feet in length, unclosed since the flood of 1897. Parts of the line are so near caving banks that new loops will be required in the near future. During the past year the United States has built 36,777 and the local authorities 110,711 cubic yards.

Upper Yazoo levee district.—The development of the line in this district is complete, and the condition of the levees is comparatively good, particularly as regards section. The grade is generally within 2 feet of the standard adopted by the Commission. Several parts of the line are threatened by caving banks, and it will become necessary in the near future to replace them with new levees.

During the past year the United States built 71,564 and the State organization 906,464 cubic yards.

Of the total amount of levees built during the year in the First and Second districts, the United States has constructed 181,817 and the State organization 1,775,665 cubic yards.

Reference is made to the appended report of Capt. E. E. Winslow,

Corps of Engineers, U. S. Army, for detailed information concerning the levees of his district. (Appendix 2.)

In the Third engineering district, under the charge of Capt. C. L. Potter, Corps of Engineers, U. S. Army, are included the following levee districts:

Lower Yazoo levee district, left bank, from the Coahoma-Bolivar County line, Mississippi, to the mouth of the Yazoo River, 227 miles.

Upper Tensas levee district, right bank, from the Arkansas River to the latitude of Warrenton, Miss., 204 miles.

Lower Yazoo levee district.—The levee line in this district is continuous from its head, in continuation of the levees of the Upper Yazoo district, down to Eagle Lake, with a length of about 188 miles. No extension is proposed. For three-fourths of this distance the crown of the levees is about the provisional grade of 3 feet above the highest known water, of 1897, but a large part of it has not the standard section. Parts of the line fall as much as 1.5 feet below this provisional grade and are also weak in section. A large amount of new work will be required in the near future as the result of caving banks.

No construction has been done in this district during the past year by the United States, the absence of funds restricting the work to surveying and maintenance. The State authorities built 1,796,900 cubic yards during the year.

Upper Tensas levee district.—The upper end of the levee of this district, forming the head of the Tensas system, rests on higher ground on the south side of Cypress Creek, Arkansas. The levee on the right bank of the Arkansas River, when completed, will lap over this interior line sufficiently to prevent backwater from flanking around the head of the system. The length of line under the jurisdiction of the United States is at present 187 miles. The grade of that part of the line in Arkansas ranges from 2 to 3 feet above the highest known water. In Louisiana it is more irregular, parts being only 1 foot above this provisional grade, while others are as much as $4\frac{1}{2}$ feet above it. This line is also deficient in section, not more than one-third having banquettes.

During the year the construction work of the United States in this levee district has amounted to 199,684 and of the States of Arkansas and Louisiana to 741,651 cubic yards.

In the Third engineering district during the past year the levee construction work done by the United States was 199,684 and by the States of Mississippi, Arkansas, and Louisiana 2,538,551 cubic yards.

For complete details concerning the levees and levee work in this district during the past year, reference is made to the appended reports of Capt. C. L. Potter, Corps of Engineers, U. S. Army, E. C. Tollinger, assistant engineer, and A. M. Todd, superintendent. (Appendix 3.)

In the Fourth engineering district, under the charge of Maj. George McC. Derby, Corps of Engineers, U. S. Army, are included the following levee districts:

Lower Tensas, right bank, extending from a point opposite Warrenton, Miss., to the mouth of Red River, 157 miles.

Atchafalaya, right bank, from the mouth of Red River to Bayou Lafourche, 122 miles.

Lafourche, right bank, extending from Bayou Lafourche to the city limits of New Orleans.

Barataria, right bank, from the city limits of New Orleans to the Head of the Passes, 82 miles.

Homochitto, left bank, from the mouth of the Yazoo River to Baton Rouge, 238 miles.

Pontchartrain, left bank, from Baton Rouge to the city limits of New Orleans, 123 miles.

Lake Borgne, left bank, from the lower limits of the city of New Orleans to the Head of the Passes, 91 miles.

In the Lower Tensas district the levees are a continuation of those in the Upper Tensas, forming the Tensas system. They are continuous, at present, to Bougere, about 26 miles above the mouth of Red River. An extension downstream of about 12 miles is now in contemplation.

In the Barataria district the levee line terminates at the Jump, 11 miles, and in the Lake Borgne district at Fort St. Philip, 21 miles above the Head of the Passes. The lines in all other districts are continuous, except in the Homochitto, where none but private levees exist.

The grades of the levees in these districts are best given in a table, here reproduced, from Major Derby's appended report. The sections conform tolerably to the standard, except the absence of banquettes from a great part of the line.

Above high water, 1897.	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria.	Lake Borgne.
	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>
Less than 1 foot.....	4.50	2.03	1.36	41.32	2.14	0.19
From 1 to 2 feet.....	9.24	2.49	17.84	31.11	28.56	35.67
From 2 to 3 feet.....	27.14	21.13	24.04	14.03	24.32	14.18
More than 3 feet.....	87.64	104.49	38.76	39.11	16.64	21.25
Total.....	128.61	130.14	82.00	125.37	71.66	71.29

The construction work during the past year by the United States and State organizations is shown in the following table from the same source:

	Levee districts.						
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria.	Lake Borgne.	Total.
	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>
By United States.....	159,109	45,933	104,119	22,518	89,757	130,416	331,679
By States.....	483,786	442,098	326,121	71,704	89,757	130,416	1,473,882
Total.....	642,895	488,031	430,240	94,222	39,757	130,416	1,805,561

For full information concerning the condition of the levees of these districts, reference is made to the appended reports of Maj. George McC. Derby and of Supt. W. E. Knoblock (Appendix 4).

The table which has formed part of the previous report giving the general condition of the entire levee system below Cairo is here reproduced, with such changes as are required to bring the information up to date.

16 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Tabulated statement of the condition of levees and of the levee work of year ending June 30, 1902.

Levee district.	Length.	Contents in 1901.	Built since by United States.	Built since by local authorities.	Total constructed.
	<i>Miles.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Upper St. Francis	85	385,898			385,898
Reelfoot	24	14,704		440,710	455,414
Lower St. Francis	207	13,270,905	73,476	758,490	14,102,871
White River	64	7,390,730	36,777	110,711	7,538,218
Upper Yazoo	124	19,190,503	71,564	906,464	20,168,531
Lower Yazoo	188.14	30,562,029		1,775,665	32,337,694
Upper Tensas	171.66	28,175,476	199,684	741,651	29,116,811
Lower Tensas	131.50	16,653,503	159,109	483,786	17,296,398
Atchafalaya	122	18,400,912	45,933	442,098	18,888,943
Lafourche	78	7,612,006	104,119	326,121	8,042,246
Barataria	71.5	2,823,222	22,518	71,704	2,917,444
Pontchartrain	123.5	13,861,050		89,757	13,900,807
Lake Borgne	70	3,198,035		130,416	3,328,451
Total		161,538,973	713,180	6,227,573	168,479,726

Levee district.	Loss during year.	Contents in 1902.	Required to complete.	Estimated final contents.	Percentage now built.
	<i>Cubic Yds.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	
Upper St. Francis		385,898	5,076,650	5,462,548	0.0706
Reelfoot		455,414	1,850,000	2,305,414	.1975
Lower St. Francis	105,190	13,997,681	10,500,000	24,497,681	.5713
White River		7,538,218	9,100,000	16,638,218	.4530
Upper Yazoo		20,168,531	7,500,000	27,668,531	.7289
Lower Yazoo	208,700	32,128,994	14,548,432	46,677,426	.6883
Upper Tensas	537,113	28,579,698	16,748,788	45,328,486	.6305
Lower Tensas	87,700	17,208,698	11,622,374	28,831,072	.5968
Atchafalaya		18,888,943	5,862,445	24,751,388	.7631
Lafourche	214,210	7,828,036	2,960,686	10,788,722	.7256
Barataria	41,360	2,876,084	1,529,943	4,406,027	.6527
Pontchartrain		13,900,807	5,137,965	19,038,772	.7301
Lake Borgne	46,913	3,281,538	1,617,205	4,898,743	.6698
Total	1,241,186	167,238,540	94,054,488	261,293,028	.6400

The cubic yardage of the levees lost by caving during the past year has been about three-fourths of 1 per cent of the amount already in place. The average amount annually lost for the past six years, during which time records have been kept, is not in excess of two-thirds of 1 per cent.

It is probable that in the near future this rate of loss will be temporarily increased, owing to the proximity of caving banks in many localities. In several cases the question of a new location is complicated by the existence of old river lakes or other obstructions in the immediate rear of the levee line.

The following table, compiled in 1900 by the Lower St. Francis levee board, gives interesting information concerning the resources of the local levee authorities. Since its date both the issue of bonds and the limit of taxation has in some districts been increased.

Table showing comparative rate of taxation, etc., for levee purposes of the several States on the Mississippi River, below Cairo.

District.	Bonds.		Mill tax.		Acreage, railroad and produce assessments.			Gross annual revenues.
	Amount authorized.	Amount outstanding.	Rate permitted.	Gross amount (ad valorem).	Rate permitted per acre.	Rate permitted per mile.	Gross amount railroad and acreage assessments.	
Reelfoot levee district, Tennessee.....	\$100,000.00	\$100,000.00	<i>Mills.</i> 5	\$6,000.00	\$0.04	\$30.00, \$10.00		\$6,000.00
St. Francis levee district, Missouri.....	750,000.00	750,000.00		(a)	.04	30.00, 10.00, 5.00	\$64,859.58	64,859.58
St. Francis levee district, Arkansas.....	1,074,000.00	1,074,000.00	11½	222,931.62	.05		92,844.23	821,819.45
Yazoo-Mississippi Delta levee district, Mississippi.....	1,150,000.00	1,150,000.00	5	82,900.78	.05		75,376.75	316,808.58
Lower Mississippi levee district, Mississippi.....								
Cotton Belt levee district, Arkansas.....								
State of Louisiana general engineer fund.....								
Atchafalaya Basin levee district, Louisiana.....	1,000,000.00	860,000.00	1	287,723.57	.024	60.00	47,236.42	287,723.57
Boesler levee district, Louisiana.....	200,000.00	199,900.00	10	139,818.64	.05	60.00	7,608.50	262,699.18
Buras levee district, Louisiana.....	35,000.00	25,000.00	10	11,137.00	.05	30.00	1,219.20	26,794.24
Caddo levee district, Louisiana.....	200,000.00	199,900.00	10	4,044.45	.05	60.00	6,580.50	8,266.58
Cat Island levee district, Louisiana.....	100,000.00		10	7,134.80	.05	100.00	(d)	21,312.05
Fifth Louisiana levee district, Louisiana.....	500,000.00	460,000.00	10	53,562.14	.024	20.00, 30.00, 60.00	50,274.55	168,637.19
Grand Prairie levee district, Louisiana.....	25,000.00	20,000.00	10	1,435.05	(e)	30.00	562.60	2,540.43
Lafourche Basin levee district, Louisiana.....	500,000.00	275,000.00	10	94,470.86	.024	50.00, 100.00	26,298.60	171,338.05
Lake Borgne levee district, Louisiana.....	100,000.00	100,000.00	10	15,785.29	.05	60.00	4,501.60	23,680.59
Orleans levee district, Louisiana.....	500,000.00	825,000.00	1	138,702.84	(u)	(u)	17,516.00	138,702.84
Pontchartrain levee district, Louisiana.....	1,044,000.00	786,000.00	10	52,283.11	.03	100.00	21,792.80	105,841.50
Red River, Atchafalaya, and Bayou Boeuf levee district, Louisiana.....	250,000.00	250,000.00	10	31,722.10	.05	60.00	(a)	53,514.90
Tensas Basin levee district, Louisiana.....	150,000.00	90,500.00	10	12,479.22	.05	30.00, 60.00	(f)	12,479.22
Total.....	6,656,200.00			1,142,121.49			415,208.33	1,960,936.95

a None authorized.

b Privilege tax.

c Cotton tax, \$1 per bale.

d None assessed.

e One dollar on each and every arpent front of land facing the Mississippi River. An arpent equals, approximately, five-sixths of an acre

f None returned.

The high water of this year reached but little more than a bank-full stage, and no expenses were incurred for flood protection. A table of the highest and lowest known gauge readings and those of the past fiscal year is here reproduced from the secretary's report:

River.	Gauge.	Lowest.	Year.	Low, 1901.	Highest.	Year.	High. 1902.
Mississippi	St. Louis	-2.52	1900	-1.94	35.95	1892	^a 21.70
Do.	Cape Girardeau	1.00	1897	2.00	31.60	1897	^a 22.00
Do.	Calro	-1.00	1871	2.88	52.17	1883	42.14
Do.	Belmont	.05	1895	3.59	45.58	1883	38.60
Do.	New Madrid	.55	1895	3.26	40.27	1897	33.24
Do.	Cottonwood	-3.35	1895	-.30	39.35	1897	32.80
Do.	Fulton	.16	1895	1.55	38.30	1898	29.55
Do.	Memphis	-2.65	1895	-.30	37.66	1897	30.90
Do.	Mhoon	-7.80	1895	-3.72	41.60	1897	34.30
Do.	Helena	-3.00	1895	1.45	51.75	1897	39.58
Do.	Sunflower	-1.50	1895	2.85	47.17	1897	38.75
Do.	White River	0.00	1872	4.55	52.42	1897	43.30
Do.	Arkansas City	-3.60	1895	1.00	51.90	1897	41.40
Do.	Greenville	-2.55	1895	.85	46.75	1897	36.05
Do.	Lake Providence	-5.30	1895	-.85	44.54	1897	34.95
Do.	Vicksburg	-6.50	1895	-2.32	52.44	1897	41.22
Do.	St. Joseph	-9.30	1895	-5.87	47.85	1897	37.15
Do.	Natchez	-.85	1895	2.05	49.82	1897	40.25
Do.	Red River	-.60	1895	2.00	50.20	1897	38.80
Do.	Bayou Sara	-2.70	1895	-1.40	43.70	1897	31.70
Do.	Baton Rouge	-.45	1894	1.30	40.65	1897	29.40
Do.	Plaquemine	-.94	1894	0.00	36.25	1897	25.60
Do.	Donaldsonville	1.00	1894	1.12	32.75	1897	23.30
Do.	College Point	-.91	1894	-.47	27.95	1897	19.50
Do.	Carrollton	-1.60	1872	.01	19.17	1897	13.35
Do.	Fort Jackson	.30	1894	.70	7.20	1897	6.35
Arkansas	Little Rock	2.01	1887	2.50	31.20	1892	19.60
Atchafalaya	Barbre Landing	-1.77	1897	.16	50.95	1897	37.38
Cumberland	Nashville	-.40	1878	1.30	55.30	1882	46.20
Ohio	Cincinnati	1.92	1881	4.10	71.06	1884	50.90
Do.	Louisville (upper)	1.70	1895	2.60	46.60	1884	24.80
Do.	Louisville (lower)	1.60	1872	3.20	72.00	1884	50.40
Do.	Paducah	-.70	1895	1.50	54.25	1884	39.70
Ouachita	Camden	1.80	1887	2.85	46.00	1882	35.10
Red	Fulton	.10	1896	3.15	35.75	1876	21.80
Do.	Shreveport	-5.50	1894	-1.00	35.70	1892	16.80
Do.	Alexandria	-3.70	1881	-2.60	38.25	1892	19.75
St. Francis	Bridge St. Louis, Iron Mountain and South- ern Rwy	-.05	1901	-.05	41.60	1897	15.80
Tennessee	Chatanooga	0.00	1883	2.10	54.00	1875	38.00
Do.	Florence	-.76	1878	.80	33.20	1897	21.70
Wabash	Mount Carmel	-.20	1895	0.00	28.80	1875	11.80
White	Jacksonport	-1.10	1872	-.75	33.35	1890	19.30
Do.	Clarendon	4.07	1887	4.35	36.63	1890	25.00
Yazoo	Yazoo City	-4.30	1875	-1.80	36.50	1882	26.60

^a June 30; river still rising.

The estimates which follow cover the amounts which, in the judgment of the Commission, can be advantageously expended beyond those provided for in the river and harbor act of June 13, 1902.

Respectfully submitted.

AMOS STICKNEY,
Colonel, Corps of Engineers, U. S. Army,
President Mississippi River Commission.

B. M. HARROD.

R. S. TAYLOR.

HENRY L. MARINDIN,
Assistant, Coast and Geodetic Survey.

J. A. OCKERSON.

H. M. ADAMS,

Lieut. Col., Corps of Engineers, U. S. Army.

THOS. L. CASEY,

Major, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,

Chief of Engineers, U. S. Army.

*Money Statements.**Appropriations expended under Mississippi River Commission.*

[Appropriation for improving Mississippi River.]

July 1, 1901, balance unexpended.....	\$1,217,230.44
Amount appropriated by river and harbor act approved June 13, 1902.....	2,290,000.00
	<hr/> 3,507,230.44
June 30, 1902, amount expended during fiscal year	\$856,579.41
Amount allotted for expenses of office of Chief of Engineers, United States Army, approved by Acting Secretary of War February 25, 1902.....	5,000.00
	<hr/> 861,579.41
July 1, 1902, balance unexpended.....	2,645,651.03
July 1, 1902, outstanding liabilities.....	\$39,432.72
July 1, 1902, amount covered by uncompleted contracts....	66,953.55
	<hr/> 106,386.27
July 1, 1902, balance available	<hr/> 2,539,264.76
Distributed as follows:	
Surveys, gauges and observations.....	7,644.46
Levees	174,702.10
Revetment and contraction works, permanent channel improvements and protection	36,991.36
Dredges and dredging	43,394.21
Plant and miscellaneous	11,527.90
Improving harbors and tributaries.....	25,933.03
Works above Cairo.....	2,571.70
Unallotted.....	2,236,500.00
	<hr/> 2,539,264.76

Amounts necessary to be appropriated for the fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902.

For continuing the improvement of the Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	\$2,000,000.00
Protection of banks at or near Caruthersville.....	30,000.00
Improving harbor at Memphis, Tenn. (including Hopefield Bend and Wolf River)	50,000.00
Improving harbor at Greenville, Miss	25,000.00
Delta Point, La. (preservation of existing works).....	25,000.00
Improving harbor at Natchez, Miss., and Vidalia, La.....	100,000.00
Rectification of Red and Atchafalaya rivers, Louisiana.....	30,000.00
Improving harbor at New Orleans, La	300,000.00
	<hr/> 2,560,000.00

^aThe unexpended balance, \$1,217,225.84, shown in annual report for 1901, was increased in December, 1901, by the following refundments of overpayments by the Fourth district officer:

Allotment for Lower Tensas levee district	\$3.10
Allotment for Kempe Bend revetment .....	.25
Allotment for plant.....	1.00
Allotment for Giles Bend.....	.25

4.60

20 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

[Appropriation for gauging the waters of the Lower Mississippi and its tributaries.^a]

July 1, 1901, balance unexpended	\$728. 24
Amount allotted by Chief of Engineers. July 31, 1901, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal year ending June 30, 1902	6, 000. 00
	<hr/> 6, 728. 24
June 30, 1902, amount expended during fiscal year	5, 885. 82
	<hr/>
July 1, 1902, balance unexpended	842. 42
July 1, 1902, outstanding liabilities	320. 00
	<hr/>
July 1, 1902, balance reverting to Treasury	522. 42
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902.....	9, 600. 00

Consolidated statement of all appropriations expended under the Mississippi River Commission to June 30, 1902.

[Appropriation for improving Mississippi River.]

Act of June 28, 1879 (organic)	\$175, 000. 00
Act of June 16, 1880 (sundry civil)	150, 000. 00
Act of March 3, 1881 (river and harbor)	1, 000, 000. 00
Act of March 3, 1881 (sundry civil)	150, 000. 00
Act of August 2, 1882 (river and harbor)	4, 123, 000. 00
Act of August 7, 1882 (sundry civil)	150, 000. 00
Act of March 3, 1883 (sundry civil)	150, 000. 00
Act of January 19, 1884 (river and harbor)	1, 000, 000. 00
Act of July 5, 1884 (river and harbor)	75, 000. 00
Act of July 5, 1884 (river and harbor), less \$5,000 transferred to snagboat service.....	2, 065, 000. 00
Act of July 7, 1884 (sundry civil)	75, 000. 00
Act of August 5, 1886 (river and harbor), less \$5,942.60 for expenses, office Chief of Engineers	1, 994, 057. 40
Act of August 5, 1886 (river and harbor), less \$47.30 for expenses, office Chief of Engineers	29, 952. 70
Act of August 11, 1888 (river and harbor), less \$4,859 for expenses, office Chief of Engineers	2, 840, 141. 00
Act of August 11, 1888 (river and harbor)	75, 000. 00
Act of October 2, 1888 (sundry civil)	35, 000. 00
Act of October 19, 1888 (deficiency), less \$4,214.39 reverted to the Treasury	20, 785. 61
Act of September 19, 1890 (river and harbor)	3, 200, 000. 00
Act of September 30, 1890 (deficiency)	5, 625. 00
Act of March 3, 1891 (deficiency)	1, 950. 00
Act of March 3, 1891 (joint resolution)	1, 000, 000. 00
Act of July 13, 1892 (river and harbor)	2, 470, 000. 00
Act of July 28, 1892 (deficiency)	44. 80
Act of March 3, 1893 (sundry civil)	2, 665, 000. 00
Act of August 18, 1894 (river and harbor)	485, 000. 00
Act of August 18, 1894 (sundry civil)	2, 665, 000. 00
Act of March 2, 1895 (sundry civil)	2, 665, 000. 00
Act of June 3, 1896 (river and harbor)	909, 000. 00
Joint resolution approved March 31, 1897 (Public, No. 6)	250, 000. 00
Act of June 4, 1897 (sundry civil)	2, 933, 333. 00
Act of July 19, 1897 (deficiency)	625, 000. 00
Act of July 1, 1898 (sundry civil)	1, 983, 333. 00
Act of March 3, 1899 (sundry civil)	2, 583, 333. 00
Act of March 3, 1899 (river and harbor)	185, 000. 00
Act of June 6, 1900 (sundry civil), less \$5,000 for expenses, office Chief of Engineers	2, 245, 000. 00
Act of June 13, 1902 (river and harbor)	90, 000. 00
Act of June 13, 1902 (river and harbor)	2, 200, 000. 00
	<hr/>
Total specific appropriations	43, 269, 555. 51

^aThe custody and care of the gauges maintained under this appropriation were assumed by the Mississippi River Commission February 11, 1901, on which date they were transferred to the secretary, under authority of Secretary of War dated January 25, 1901.

MISSISSIPPI RIVER COMMISSION.

21

Balances from former appropriations applied to works
below Cairo under act of August 2, 1882, less \$123.42
reverted to Treasury.....\$272,504.96
Same for works above Cairo, under act of July 5, 1884.... 22,632.53

Total balances \$295,137.49
Amount received from Quartermaster's Department, United States
Army, September 21, 1898, on account reimbursement for plant
loaned during war of 1898 and lost at sea (taken up by Fourth dis-
trict officer in January, 1899) 8,000.00
Total..... 43,572,693.00

EXPENDED.

Location and object.	To June 30, 1901.	During year ending June 30, 1902.	Total.
Mississippi River Commission.....	\$609,444.05	\$32,124.39	\$641,568.44
Surveys, gauges, and observations.....	1,885,491.95	47,822.71	1,933,314.66
Levees.....	a 16,411,795.78	168,819.09	16,580,614.87
Revetment and contraction works, permanent- channel improvements and protection.....	b 10,076,560.27	69,784.10	10,146,344.37
Dredges and dredging.....	2,466,491.29	313,413.32	2,779,904.61
Experimental dikes.....	84,000.00		84,000.00
Plant and miscellaneous.....	c 1,691,544.87	44,784.80	1,736,329.67
Improving harbors and tributaries.....	d 6,110,073.52	179,831.00	6,289,904.52
Works above Cairo.....	735,060.83		735,060.83
Total expended.....	40,070,462.56	856,579.41	40,927,041.97
Balance unexpended June 30, 1902.....			409,151.03
Unallotted.....			2,236,500.00
Total appropriated, etc.....			43,572,693.00

a The amount, \$16,411,798.88, reported in annual report for 1901, was reduced during fiscal year
by the following refundment of overpayment: By Fourth district officer, December, 1901,
allotment for Lower Tensas levee district..... \$3.10
b The amount, \$10,076,560.52, reported in annual report for 1901, was reduced during fiscal year
by the following refundment of overpayment: By Fourth district officer, December, 1901,
allotment for Kempe Bend revetment..... .25
c The amount, \$1,691,545.87, reported in annual report for 1901, was reduced during fiscal year
by the following refundment of overpayment: By Fourth district officer, December, 1901,
allotment for plant..... 1.00
d The amount, \$6,110,073.77, reported in annual report for 1901, was reduced during fiscal year
by the following refundment of overpayment: By Fourth district officer, December, 1901,
allotment for Giles Bend..... .25
4.60

[Appropriation for gauging the waters of the Lower Mississippi and its tributaries.]

Allotments from general appropriations for examinations, surveys, and
contingencies of rivers and harbors by acts of—
March 3, 1871..... \$5,000.00
June 10, 1872..... 5,000.00
March 3, 1873..... 5,000.00
June 23, 1874..... 5,000.00
March 3, 1875..... 5,000.00
Specific appropriations by river and harbor acts of—
August 14, 1876..... 5,000.00
June 18, 1878..... 5,000.00
March 3, 1879..... 5,000.00
June 14, 1880..... 5,000.00
March 3, 1881..... 5,000.00
August 2, 1882..... 5,000.00
Deficiency act of March 12, 1884..... 2,100.00
Specific appropriations by river and harbor acts of—
July 5, 1884..... 5,000.00
August 5, 1886..... 5,000.00
Allotted from specific appropriation by river and harbor act of August
11, 1888..... 8,700.00
Deficiency act of October 19, 1888..... 3,600.00

a The custody and care of the gauges maintained under this appropriation were assumed by the
Mississippi River Commission February 11, 1901, on which date they were transferred to the secre-
tary, under authority of Secretary of War, dated January 25, 1901.

22 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:

1880.....	\$9,000.00
1891 (less \$3,518.34 withheld in United States Treasury under ruling that only \$6,000 can be expended each fiscal year)	5,181.66
1892.....	5,100.00
1893.....	5,500.00
1894.....	5,500.00
1895.....	5,500.00
1896.....	5,500.00
1897.....	5,500.00
1898.....	5,500.00
1899.....	6,000.00
1900.....	5,500.00
1901.....	6,000.00
1902.....	6,000.00
Total	155,181.66

EXPENDED.

	To June 30, 1901.	During year ending June 30, 1902.	Total.
Expenditures.....	\$141,503.97	\$5,885.82	\$147,389.79
Unexpended balances reverted to Treasury.....	6,949.46	522.42	7,471.87
Total	148,453.42	6,408.24	154,861.66
Unexpended balance June 30, 1902.....			320.00
Total appropriated, etc.			155,181.66

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902.

SECRETARY MISSISSIPPI RIVER COMMISSION.

[Appropriations: Improving Mississippi River; gauging the waters of the Lower Mississippi and its tributaries.]

	Appropriation for improving Mississippi River, allotment for—				
	Mississippi River Commis- sion.	Surveys, gauges, and observa- tions.	Dredges and dredging.	Expended allotments.	Total.
Amount expended on previous projects.....	\$238,110.74	\$855,247.37			\$1,093,358.11
Amount expended on present project to end of last fiscal year.....	371,333.31	754,493.72	\$2,075,887.18	4 46,131.14	3,247,845.35
Balance unexpended at end of last fiscal year.....	^b 32,155.69	50,941.61	^c 425,807.12		508,904.42
Amount appropriated or allotted since (net)		6,500.00			6,500.00
	32,155.69	57,441.61	425,807.12		515,404.42

^a Experimental dikes, \$45,075.58; patrol of the Mississippi River, \$1,055.56.

^b Amount \$27,155.69 reported in annual report for 1901, increased \$5,000 transferred from allotment for dredges and dredging in February, 1902.

^c Amount \$435,807.12 reported in annual report for 1901, reduced \$5,000 transferred to allotment for Mississippi River Commission in February, 1902, and \$5,000 allotted and transferred for expenses of office of Chief of Engineers, United States Army, in March, 1902.

MISSISSIPPI RIVER COMMISSION.

23

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

SECRETARY MISSISSIPPI RIVER COMMISSION—Continued.

	Appropriation for Improving Mississippi River, allotment for—				
	Mississippi River Commission.	Surveys, gauges, and observations.	Dredges and dredging.	Expended allotments.	Total.
Amount expended from beginning of present fiscal year to end of previous month.....	\$30,394.35	\$40,665.59	\$302,226.60		\$373,286.54
Amount expended during the month.....	1,730.04	a 4,787.46	11,180.72		17,704.22
	32,124.39	45,453.05	313,413.32		390,990.76
Balance unexpended at end of month.....	31.30	11,988.56	112,393.80		124,413.66
In Treasury United States.....	11.03	4,667.74	80,472.10		85,150.87
In hand.....	20.27	7,320.82	31,921.70		39,262.79
	31.30	11,988.56	112,393.80		124,413.66
Outstanding liabilities at end of month.....	31.30	4,844.10	25,734.49		30,109.89
Amount covered by existing contracts at end of month.....			43,265.10		43,265.10
	31.30	4,844.10	68,999.59		73,374.99
Balance available at end of month.....		7,644.46	43,391.21		51,038.67
					Grand total.
Amount expended on previous projects.....					\$1,093,358.11
Amount expended on present project to end of last fiscal year.....				\$141,503.97	3,389,349.32
Balance unexpended at end of last fiscal year.....				728.24	509,632.66
Amount appropriated or allotted since (net).....				6,000.00	12,500.00
				6,728.24	522,132.66
Amount expended from beginning of present fiscal year to end of previous month.....				4,819.17	378,105.71
Amount expended during the month.....				1,066.65	18,770.87
				5,885.82	396,876.58
Balance unexpended at end of month.....				842.42	125,256.08
In Treasury United States.....					85,150.87
In hand.....				842.42	40,105.21
				842.42	125,256.08
Outstanding liabilities at end of month.....				320.00	30,429.89
Amount covered by existing contracts at end of month.....					43,265.10
				320.00	73,694.99
Balance available at end of month.....				(b)	51,038.67

^a Includes \$1.88 in Treasury settlement No. 18871 of May 26, 1902, with Minneapolis and St. Louis Railroad Company for freight transportation. (135-115 Sec. M. R. C.)

^b Balance of \$622.42 reverts to Treasury.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

WORKS ABOVE CAIRO.

[Appropriation: Improving Mississippi River.]

	Protection near Cairo. ^a	Des Moines Rapids to Ohio River.	Total.
Amount expended on previous projects.....			
Amount expended on present project to end of last fiscal year.....	\$47,428.30	\$687,632.53	\$735,060.83
Balance unexpended at end of last fiscal year.....	2,571.70		2,571.70
Amount appropriated or allotted since (net).....	2,571.70		2,571.70
Amount expended from beginning of present fiscal year to end of previous month.....			
Amount expended during the month.....			
Balance unexpended at end of month.....	2,571.70		2,571.70
In Treasury United States.....	2,571.70		2,571.70
In hand.....	2,571.70		2,571.70
Outstanding liabilities at end of month.....			
Amount covered by existing contracts at end of month.....			
Balance available at end of month.....	2,571.70	2,571.70	2,571.70

^aIncludes only work under act of July 5, 1884.

FIRST AND SECOND DISTRICTS.

[Appropriations: Improving Mississippi River: levee at Walnut Bend, Ark.; improving harbor at Memphis, Tenn.]

	Improving Mississippi River, allotment for—				
	Surveys, gauges, and observations.	Upper St. Francis levee district.	Lower St. Francis levee district.	White River levee district.	Upper Yazoo levee district.
Amount expended on previous projects.....					
Amount expended on present project to end of last fiscal year.....	\$108,841.16	\$40,000.00	\$669,725.49	\$1,180,997.68	\$1,139,706.56
Balance unexpended at end of last fiscal year.....	331.95		32,201.51	14,736.92	26,645.22
Amount appropriated or allotted since (net).....	331.95		32,201.51	14,736.92	26,645.22
Amount expended from beginning of present fiscal year to end of previous month.....	200.70		21,869.01	10,362.40	18,176.34
Amount expended during the month.....	12.20		259.20	161.00	922.76
	212.90		22,128.21	10,523.40	19,098.10
Balance unexpended at end of month.....	119.05		10,073.30	4,213.52	7,547.12
In Treasury United States.....			8,000.00	3,000.00	6,000.00
In hand.....	119.05		2,073.30	1,213.52	1,547.12
	119.05		10,073.30	4,213.52	7,547.12
Outstanding liabilities at end of month.....	119.05		273.30	213.52	547.12
Amount covered by existing contracts at end of month.....					
	119.05		273.30	213.52	547.12
Balance available at end of month.....			9,800.00	4,000.00	7,000.00

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River, allotment for—				
	Plum Point Reach.	Plant.	At Hickman, Ky.	At New Madrid, Mo.	Caruthersville, Mo.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	\$5,050,016.02	\$781,941.38	\$92,718.61	\$148,234.60	\$54,598.61
Balance unexpended at end of last fiscal year	6,644.60	17,758.60	2,413.39	3,765.40	401.39
Amount appropriated or allotted since (net)	6,644.60	17,758.60	2,413.39	3,765.40	401.39
Amount expended from beginning of present fiscal year to end of previous month	5,952.61	12,597.93	1,536.61	1,974.49	399.96
Amount expended during the month		1,162.25			
	5,952.61	13,760.18	1,536.61	1,974.49	399.96
Balance unexpended at end of month	691.99	3,998.42	876.78	1,790.91	1.43
In Treasury United States		3,000.00			
In hand	691.99	998.42	876.78	1,790.91	1.43
	691.99	3,998.42	876.78	1,790.91	1.43
Outstanding liabilities at end of month	91.99	498.42			1.43
Amount covered by existing contracts at end of month					
	91.99	498.42			1.43
Balance available at end of month	600.00	3,500.00	876.78	1,790.91	

	Improving Mississippi River, allotment for—				
	Hopefield Bend (preservation of works at).	At Memphis, Tenn.	At Helena, Ark.	Expended allotments.	Total.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	\$121,580.00	\$38,492.49	\$198,125.48	\$637,839.43	\$10,257,817.51
Balance unexpended at end of last fiscal year	8,420.00	6,507.51	2,374.52		122,201.01
Amount appropriated or allotted since (net)	8,420.00	6,507.51	2,374.52		122,201.01
Amount expended from beginning of present fiscal year to end of previous month	6,112.07	5,943.44	1,805.32		86,929.88
Amount expended during the month		186.17	178.72		2,882.30
	6,112.07	6,129.61	1,984.04		89,812.18

^a Preservation of works, \$54,867.89; removal of Nonconah Rock, \$9,000; dredges and dredging, \$388,097.12; Columbus, Ky., \$43,750; improving St. Francis River (Walnut Bend levee), \$75,000; preservation of works at Walnut Bend levee, \$28,200; experimental dikes, \$38,924.42.

26 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River, allotment for—				
	Hopefield Bend (preservation of works at).	At Memphis, Tenn.	At Helena, Ark.	Expended allotment.	Total.
Balance unexpended at end of month.....	\$2,807.93	\$377.90	\$390.48		\$32,388.83
In Treasury United States.....					20,000.00
In hand.....	2,807.93	377.90	390.48		12,388.83
	2,807.93	377.90	390.48		32,388.83
Outstanding liabilities at end of month.....					1,744.83
Amount covered by existing contracts at end of month.....					
					1,744.83
Balance available at end of month.....	2,807.93	377.90	390.48		30,644.00

	Improving harbor at Memphis, Tenn.				Grand total.
	Levee at Walnut Bend, Ark.	Improving harbor at Memphis, Tenn.	Improving harbor at Memphis, Tenn. (Wolf River).	Total.	
Amount expended on previous projects.....					
Amount expended on present project to end of last fiscal year.....		\$1,425,038.77	\$44,861.63	\$1,469,900.40	\$11,727,717.91
Balance unexpended at end of last fiscal year.....			138.37	138.37	122,339.38
Amount appropriated or allotted since (net).....	\$90,000.00			90,000.00	90,000.00
	90,000.00		138.37	90,138.37	212,339.38
Amount expended from beginning of present fiscal year to end of previous month.....			138.37	138.37	87,068.25
Amount expended during the month.....					2,882.30
			138.37	138.37	89,950.55
Balance unexpended at end of month.....	90,000.00			90,000.00	122,388.83
In Treasury United States.....	90,000.00			90,000.00	110,000.00
In hand.....					12,388.83
	90,000.00			90,000.00	122,388.83
Outstanding liabilities at end of month.....					1,744.83
Amount covered by existing contracts at end of month.....					
					1,744.83
Balance available at end of month.....	90,000.00			90,000.00	120,644.00

MISSISSIPPI RIVER COMMISSION.

27

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

THIRD DISTRICT.

[Appropriation: Improving Mississippi River.]

	Improving Mississippi River, allotment for—				
	Surveys, gauges, and observations.	Lower Yazoo levee district.	Upper Tensas levee district.	Ashbrook Neck.	Lake Providence Reach.
Amount expended on previous projects.....					
Amount expended on present project to end of last fiscal year.....	\$80,772.56	\$2,908,252.29	\$4,223,904.07	\$567,457.25	\$3,728,638.09
Balance unexpended at end of last fiscal year.....	2,156.76	26,990.10	63,753.73	9.39	5.59
Amount appropriated or allotted since (net).....					50,000.00
	2,156.76	26,990.10	63,753.73	9.39	50,005.59
Amount expended from beginning of present fiscal year to end of previous month.....	2,146.94	12,656.76	51,526.53		40,505.02
Amount expended during the month.....	9.82	1,104.01	1,869.45	9.39	
	2,156.76	13,760.77	53,395.98	9.39	40,505.02
Balance unexpended at end of month.....		13,229.33	10,357.75		9,500.57
In Treasury United States.....		12,000.00	10,000.00		
In hand.....		1,229.33	357.75		9,500.57
		13,229.33	10,357.75		9,500.57
Outstanding liabilities at end of month.....		1,500.00	1,200.00		
Amount covered by existing contracts at end of month.....					
		1,500.00	1,200.00		
Balance available at end of month.....		11,729.33	9,157.75		9,500.57

	Improving Mississippi River, allotment for—				
	Stone.	Plant.	Greenville, Miss.	Expended allotments.	Total.
Amount expended on previous projects.....					
Amount expended on present project to end of last fiscal year.....	\$232,580.37	\$779,335.37	\$878,113.37	\$774,339.02	\$14,168,342.39
Balance unexpended at end of last fiscal year.....	7,469.63	22,765.08	2.20		123,152.48
Amount appropriated or allotted since (net).....		15,000.00			65,000.00
	7,469.63	37,765.08	2.20		188,152.48
Amount expended from beginning of present fiscal year to end of previous month.....	1,819.43	25,316.60			133,971.28
Amount expended during the month.....	145.00	1,920.58	2.20		5,060.45
	1,964.43	27,237.18	2.20		139,031.73

^a Lake Bolivar front, \$145,358.04; improving harbor at Vicksburg, Miss., \$442,724.77; Delta Point, Louisiana, \$186,256.21.

28 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

THIRD DISTRICT—Continued.

	Improving Mississippi River, allotment for—				
	Stone.	Plant.	Greenville, Miss.	Expended allotments.	Total.
Balance unexpended at end of month.....	\$5,505.20	\$10,527.90			\$49,120.75
In Treasury United States.....	4,000.00	10,500.00			36,500.00
In hand	1,505.20	27.90			12,620.75
	5,505.20	10,527.90			49,120.75
Outstanding liabilities at end of month.....	200.00	2,500.00			5,400.00
Amount covered by existing contracts at end of month.....	200.00	2,500.00			5,400.00
Balance available at end of month..	5,305.20	8,027.90			43,720.75

FOURTH DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor of Natchez, Miss., and Vidalia, La.; improving harbor of New Orleans, La.; improving Atchafalaya and Red Rivers, Louisiana.]

	Improving Mississippi River, allotment for—				
	Surveys, gauges, and observations.	Lower Tennessee levee district.	Atchafalaya levee district.	Lafourche levee district.	Barataria levee district.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year.....	\$91,137.14	\$2,417,490.51	\$1,399,094.56	\$536,980.15	\$327,578.71
Balance unexpended at end of last fiscal year		40,558.43	26,015.10	19,503.77	7,154.16
Amount appropriated or allotted since (net)		40,558.43	26,015.10	19,503.77	7,154.16
Amount expended from beginning of present fiscal year to end of previous month		26,664.37	998.73	11,409.37	3,717.55
Amount expended during the month.....		847.91	925.53	558.03	356.50
		27,512.28	1,924.26	11,967.40	4,074.05
Balance unexpended at end of month.....		13,046.15	24,090.84	7,536.37	3,080.11
In Treasury United States.....			10,000.00		
In hand		13,046.15	14,090.84	7,536.37	3,080.11
		13,046.15	24,090.84	7,536.37	3,080.11
Outstanding liabilities at end of month.....		74.26	143.73	53.04	959.95
Amount covered by existing contracts at end of month.....			9,578.26		
		74.26	9,721.99	53.04	959.95
Balance available at end of month.....		12,971.89	14,368.85	7,483.33	2,120.16

^a The amount, \$2,417,493.61, reported in annual report for 1901, was reduced in December, 1901, \$3.10 refundment of overpayment.

^b The amount, \$40,555.33, reported in annual report for 1901, was increased in December, 1901, \$3.10 refundment of overpayment.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1903—Continued.

FOURTH DISTRICT—Continued.

	Improving Mississippi River, allotment for—				
	Pontchar- train levee district.	Lake Borgne levee dis- trict.	Bondurant.	Kempe bend revetment.	Plant.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	\$1,102,741.16	\$290,215.60	\$20,000.00	^a \$286,601.61	^b \$129,212.56
Balance unexpended at end of last fiscal year	20,093.32	4,979.53		^c 43,398.39	^d 3,787.44
Amount appropriated or allotted since (net)	20,093.32	4,979.53		43,398.39	3,787.44
Amount expended from beginning of present fiscal year to end of previous month	2,756.17	1,297.34		16,834.13	3,787.44
Amount expended during the month	181.05	200.08		4,518.52	
	2,937.22	1,497.42		21,352.65	3,787.44
Balance unexpended at end of month	17,156.10	3,482.11		22,045.74	
In Treasury United States					
in hand	17,156.10	3,482.11		22,045.74	
	17,156.10	3,482.11		22,045.74	
Outstanding liabilities at end of month	114.73	342.50		460.15	
Amount covered by existing contracts at end of month	14,110.19				
	14,224.92	342.50		460.15	
Balance available at end of month	2,931.18	3,139.61		21,585.59	

	Improving Mississippi River, allotment for—			
	Giles Bend.	Harbor at New Orleans, La.	Expended al- lotments.	Total.
Amount expended on previous projects				
Amount expended on present project to end of last fiscal year	^e \$253,256.50	\$16,591.47	^f \$136,506.99	\$7,007,406.96
Balance unexpended at end of last fiscal year	^g 6,743.50	2,158.53		174,392.17
Amount appropriated or allotted since (net)	6,743.50	2,158.53		174,392.17
Amount expended from beginning of present fiscal year to end of previous month	6,743.50	2,158.53		76,367.13
Amount expended during the month				7,587.62
	6,743.50	2,158.53		83,954.75

^aThe amount, \$286,601.86, reported in annual report for 1901, was reduced in December, 1901, 25 cents refundment of overpayment.

^bThe amount, \$129,215.56, reported in annual report for 1901, was reduced in December, 1901, \$1 refundment of overpayment.

^cThe amount, \$43,398.14, reported in annual report for 1901, was increased in December, 1901, 25 cents refundment of overpayment.

^dThe amount, \$3,786.44, reported in annual report for 1901, was increased in December, 1901, \$1 refundment of overpayment.

^eThe amount, \$253,256.75, reported in annual report for 1901, was reduced in December, 1901, 25 cents refundment of overpayment.

^fPreservation of works, \$134,000; dredges and dredging, \$2,506.99.

^gThe amount, \$6,743.25, reported in annual report for 1901, was increased in December, 1901, 25 cents refundment of overpayment.

30 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1902—Continued.

FOURTH DISTRICT—Continued.

	Improving Mississippi River, allotment for—			
	Giles Bend.	Harbor at New Orleans, La.	Expended allotments.	Total.
Balance unexpended at end of month				\$90,437.42
In Treasury United States				10,000.00
In hand				80,437.42
				90,437.42
Outstanding liabilities at end of month				2,148.36
Amount covered by existing contracts at end of month				23,688.45
				25,836.81
Balance available at end of month				64,600.61
	Improving harbor of Natchez, Miss., and Vidalia, La.	Improving harbor of New Orleans, La.	Improving Atchafalaya and Red rivers, Louisiana.	Grand total.
Amount expended on previous projects				
Amount expended on present project to end of last fiscal year	\$241,905.69	\$880,637.62	\$968,187.70	\$9,098,137.97
Balance unexpended at end of last fiscal year	40,346.35	99,002.24	33,521.70	347,262.46
Amount appropriated or allotted since (net)				
	40,346.35	99,002.24	33,521.70	347,262.46
Amount expended from beginning of present fiscal year to end of previous month	40,346.35	77,170.19	32,941.26	226,824.93
Amount expended during the month		1,613.38	580.44	9,781.44
	40,346.35	78,783.57	33,521.70	236,606.37
Balance unexpended at end of month		20,218.67		110,656.09
In Treasury United States				10,000.00
In hand		20,218.67		100,656.09
		20,218.67		110,656.09
Outstanding liabilities at end of month		29.64		2,178.00
Amount covered by existing contracts at end of month				23,688.45
		29.64		25,866.45
Balance available at end of month		20,189.03		84,789.64

LIST OF APPENDIXES ACCOMPANYING THE ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

Appendix 1.

	Page.
Report of Capt. G. P. Howell, secretary of the Commission, on work done in office of the Commission, on surveys, gauges, and observations, and dredges and dredging (65 plates).....	32
Money statements.....	45
Abstract of contracts in force.....	47
Commercial statistics.....	47
Statement of charts issued and sold.....	49
1 A.—Laws affecting the Mississippi River Commission, July 1, 1901, to June 30, 1902.....	49
1 B.—Report of Assistant Engineer Kivas Tully on gauges, discharge observations, reduction of physical data, and office publications.....	52
1 C.—Report of Assistant Engineer C. W. Sturtevant on dredging operations on the Mississippi River between Head of the Passes and mouth of the Ohio River, and care and repair of dredging plant, to include December 31, 1901.....	74
1 D.—Report of Assistant Engineer F. B. Malthy on care and repair of dredging plant since January 1, 1902.....	89

Appendix 2.

Report of Capt. E. Eveleth Winslow of operations in the First and Second districts (6 plates).....	90
Report of Assistant Engineer A. J. Noltz on operations at Plum Point Reach.....	100
Report of Assistant Engineer W. M. Rees on operations at Hopefield Bend and in Wolf River.....	101
Report of Assistant Engineer A. J. Noltz on care of and repairs to plant..	104
Money statement.....	105

Appendix 3.

Report of Capt. Charles L. Potter of operations in the Third district (3 plates).....	108
Report of Assistant Engineer Arthur Hider on surveys, revetment work, stone, and plant, with report of Mr. George C. Thomas appended....	113
Report of A. Miller Todd, superintendent, on levees in Lower Yazoo district.....	121
Report of Assistant Engineer E. C. Tollinger on levees in Upper Tensas district.....	127
Table showing cost of work done by the United States on levees.....	133
Money statement.....	134
Abstract of contracts in force.....	136

Appendix 4.

Report of Maj. George McC. Derby of operations in the Fourth district (9 plates).....	136
4 A.—Commercial statistics.....	153
4 B.—Report of Assistant Engineer H. S. Douglas on revetment work....	154
4 C.—Report of Junior Engineer L. E. Lion on dredging at mouth of Red River.....	170
4 D.—Report of W. E. Knobloch, superintendent, on levees.....	171

APPENDIX 1.

REPORT OF CAPT. G. P. HOWELL, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., May 31, 1902.

COLONEL: I have the honor to submit the following report of operations under this office for the year ending May 31, 1902:

Capt. Mason M. Patrick, Corps of Engineers, was in charge as secretary up to August 12, 1901, on which date I relieved him in accordance with Special Orders, No. 172, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., July 25, 1901.

The work in charge of the secretary of the Mississippi River Commission is carried on under allotments made by the Commission from appropriations for improving the Mississippi River between the Head of the Passes and the mouth of the Ohio River, and from allotment for fiscal year from permanent appropriation made by section 6 of river and harbor act of August 11, 1888, for gauging the waters of the Mississippi River and its tributaries.

The allotments from the appropriations for improving the Mississippi River are as follows:

(1) *Mississippi River Commission*.—Available for salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission.

(2) *Surveys, gauges, and observations*.—Available for the survey of the Mississippi River between the Head of the Passes and its headwaters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(3) *Dredges and dredging*.—Available for the operation and maintenance of dredges and dredging plant for the Mississippi River from the Head of the Passes to the mouth of the Ohio River.

The allotment from the permanent appropriation for gauging is available for paying gauge observers and other expenses incident to maintaining gauges at specified places on the Mississippi River and its tributaries.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission held three sessions during the year, as follows: Eighty-third session, June 20-22, 1901, at the president's office, St. Louis, Mo.

Eighty-fourth and eighty-fifth sessions, November 7-17, 1901, and April 2-8, 1902, respectively, on board the U. S. S. *Mississippi*, St. Louis, Mo., to New Orleans, La.

Plant and outfit.—The steamer *Mississippi* has been in service with the Commission on its inspection trips, and the balance of the time has been laid up at West Memphis, Ark. A new heating system has been installed during the year. Arrangements are being made to dock this boat for repairs to hull and renewal, in part, of bottom plating.

SURVEYS, GAUGES, AND OBSERVATIONS.

Survey of the Mississippi River.—This survey, which is authorized by the law creating the Mississippi River Commission to extend from the Head of the Passes to the headwaters of the river, has been made with the view of obtaining accurate data for topographical and hydrographical maps for use in study of the river in connection with planning improvements. The most approved methods have mainly been used in this work. The survey marks are intended to be permanent and to serve as a basis for future surveys to ascertain changes in the river.

The field work comprises secondary triangulation, precise levels, topography, and hydrography. The instructions to field parties for this work will be found in Report of the Chief of Engineers for 1891, pages 3474-3485; the instructions for precise leveling, revised, will be found in Report of the Chief of Engineers for 1899, pages 3469-3474.

A summary of the surveys of the river to 1896 will be found in Report of Chief of Engineers for 1896, pages 3574-3576; the progress of the work since will be found in the several annual reports. A summary of the work to May 31, 1901, will be found in the Supplement to Report of Chief of Engineers for 1901, page 42. As stated in this summary, the secondary triangulation and precise levels extend from the Gulf of Mexico to the headwaters at Lake Itasca, a distance of about 2,347 miles. These follow the river as far as Aitkin, Minn., a distance of about 2,147 miles. From

Brainerd, Minn., about 55 miles below Aitkin, the triangulation is carried directly across country to Lake Itasca and thence down the river to Lake Bemidji. From Lake Bemidji a base line, whose length and azimuth were carefully determined, was carried along the railroad to below Grand Rapids, Minn., on the Mississippi (1,165^a); this is to form the basis of the topographic work along the river and will be extended down to Aitkin (1,086^a). The precise levels were also carried across the country from Brainerd to Lake Bemidji and thence to Lake Itasca, on the one hand, and to Grand Rapids, Minn., on the other.

A map showing the river from Brainerd, Minn., to Lake Itasca, the triangulation and measured base line, and lines of precise levels will be found on plate 1, opposite page 232, Supplement to Report of Chief of Engineers for 1901.

Some of the precise levels on the lower river have been rerun since 1898 up the river as far as Fort Adams, Miss., and show discrepancies in the earlier levels; a statement of the results of the releveling and reasons for continuing the releveling farther upstream will be found in Report of Chief of Engineers for 1900, page 4559. As the elevations of all the survey marks and the permanent water gauges are to be ultimately referred to mean Gulf level, it seems extremely desirable that this releveling should be extended, as soon as possible, from Fort Adams to at least Arkansas City, Ark., to connect with the precise levels run by the United States Engineer office at Vicksburg, Miss., and with a more recent line of the United States Coast and Geodetic Survey.

The topography and hydrography cover the river from the Head of the Passes to Aitkin, Minn., about 2,146 miles of river. The topography and hydrography of Itasca State Park and of a portion of the river in that vicinity has also been completed.

WORK DURING THE YEAR.

General survey work.—Owing to the limited amount of funds available last season, but little work could be undertaken. A small additional allotment was made in November, 1901, under which some field work is now in progress. The work done since May 31, 1901, is as follows:

Topography and hydrography.—This comprised two stretches, aggregating about 47 miles of river, the upper one being in the vicinity of Aitkin, Minn. (1,086^a), and the lower one in the vicinity of Little Falls, Minn. (995^a), which had been omitted, in part, in 1899, on account of high water prevailing that season. Low-water slope was also determined between Aitkin and Minneapolis.

Early in September a party was organized at Aitkin for this work, as follows: Mr. A. T. Morrow, assistant engineer in charge and hydrographer; Mr. E. J. Thomas, topographer; Mr. F. A. Snyder, leveler, and about ten men, comprising recorders, rodmen, leadsmen, oarsmen, and cook. A teamster and team also accompanied the party for moving camp, etc.

On account of illness Assistant Engineer Morrow was obliged to relinquish charge of the work about the end of September. He was succeeded by Mr. E. L. Harman, who remained in charge of the party until the close of the season.

Field work was begun at Aitkin, Minn., on September 6. The work was extended above Aitkin about 6 miles to (A) Seeley and was then carried down the river from Aitkin to (B) Pine Knoll, 22 miles below Aitkin, making about 26 miles of river covered. Work was completed at (B) Pine Knoll October 9. A gauge was established at Aitkin high bridge October 8, 1901.

Camp was moved down to Belle Prairie, above Little Falls, Minn., October 10 to 13. On October 14 work was begun about 2 miles above stone line 305 and carried thence downstream, reaching stone line 299, the end of this stretch, by November 11. On this last stretch, which covered about 21 miles of river, a considerable part of the topography had been done in 1899. This season's hydrographic work was rendered somewhat difficult on this stretch by reason of the great number of logs in the river.

On conclusion of this work, on November 11, the party was disbanded at Little Falls and the property was sent back to Aitkin, the skiffs being shipped by rail and Mr. Harman, with camp outfit, going by team. The property was stored at Aitkin in care of a watchman, except such as was required by the level party.

Low-water slope.—On November 15 Mr. Harman, with one recorder, teamster and team, and small camping outfit, began the determination of low-water slopes of the river from Aitkin to Minneapolis. This work consisted of leveling at each successive stone line from the nearest stone line bench mark to the water surface in the river. Beginning at (A) Seeley levels were taken at all the stone lines, with a few exceptions

^a Miles above Cairo.

where the proximity of dams made the water surface level for some distance and where levels had been run the same season by the topographic party.

This work was completed to Minneapolis on December 4, 1901. The property used on the trip was sent back to Aitkin to be stored with other survey property at that place.

The elevations of water surface thus determined will be found in Table No. 1.

Tape-line measurements and precise levels.—A small allotment was made, approved by the Secretary of War December 1, 1901, for extending the base-line measurements and precise levels from Grand Rapids, Minn., to Aitkin, Minn., a distance of about 79 miles by river.

A party for this work was organized and camp established at Aitkin, Minn., (1,086^a), on March 22. The combined party for tape measurement and triangulation and for precise leveling consisted of about 25 persons, beside 5 teamsters with teams. The party was organized as follows, and is still in the field: Mr. George H. French, assistant engineer, in charge; Mr. E. L. Harman, precise leveler; Mr. George H. Wolbrecht, measurer of angles and tape-line work; Mr. E. E. Whitehead, computer; also recorders, surveymen, cook, etc.

Field work was begun at Aitkin, on March 25. Two triangulation stations were established on the right bank from the secondary triangle side Seeley-Stewart, from which to begin the tape measurements along the State road toward Grand Rapids, Minn. The tape measurements and precise levels have been carried along this road and on May 1 had reached a point about 25 miles above Aitkin, Minn. It is expected Grand Rapids will be reached by July 1.

The progress has been much impeded by the large amount of clearing to be done for the tape line, the condition of the roads to be traveled from camp to the place of work, and the unfavorable atmospheric conditions caused by the difference in temperature between the air currents, heated by the sun, and the currents along the ground, in contact with the melting ice. The methods employed are, in general, those used in the previous tape-line work from Bemidji to Grand Rapids, as described in the report of Assistant Engineer A. T. Morrow, page 57, Supplement to Report of Chief of Engineers for 1901; the modifications are caused by the difference in conditions, as Mr. Morrow's work was along a railway track, while the present work is through a forest, necessitating clearing out timber for the alignment.

Plant and outfit.—The floating plant now consists of the steamers *Search* and *Patrol*, and some small boats and skiffs. The *Search* has been practically transferred to service of dredges and dredging. The *Patrol* was engaged in gauge inspection service during October, November, and December, 1901; in discharge observations during parts of January and April, 1902; and for a part of January, 1902, under dredges and dredging. When not in service the *Patrol* has been cared for at West Memphis, Ark., (232 R.), where a new steam-heating system was put in and general repairs made to hull and machinery. Authority has been granted for the purchase of new boilers.

Reduction and platting of field notes.—The platting of field notes of the topographical and hydrographical survey, St. Paul to Aitkin, Minn., season of 1899, was completed. Progress was made in the reduction and platting of the field notes of the survey made in the autumn of 1901, to fill in the gaps in the above stretch in the vicinity of Aitkin and Little Falls, Minn. The field notes of topographical and hydrographical survey of Itasca State Park and vicinity, season of 1900, were platted.

Mapping.—A map of the St. Francis Basin in two sheets, scale of 1 inch to 1 mile, is about two-thirds completed. This map has been compiled from surveys made by this office and from State and railroad surveys.

Progress was made on inch-to-mile maps Nos. 131 to 135, inclusive, Trempealeau, Wis., to the lower limits of St. Paul, Minn.

Detail charts 187, 188, and 189, scale 1:10000, cities of St. Paul and Minneapolis, Minn., were finished. This completes this series from Head of Passes to Minneapolis.

Detail charts Nos. 206 to 212, inclusive, scale 1:5000, were completed. These extend from the neighborhood of Dayton, Minn., to above Clearwater, Minn., a distance of about 40 miles. Charts Nos. 201 to 205, inclusive, are completed and are ready for publication. Charts Nos. 213 to 219, inclusive, of the same series above Minneapolis are now partly drawn.

A map of Itasca State Park, scale 1:7500, to be printed in colors, was partly drawn; 1 of the color sheets was completed and progress was made on 2 others.

Shore lines from the latest surveys, improvement works, and controlling levee lines were drawn on 13 sets of 1:20000 series of published charts below Cairo. These are for the use of Commissioners, district officers, and others.

^a Miles above Cairo.

Published maps.—No maps or charts were published by this office during the past year. The maps and charts previously published by the Commission are as follows: A map of the lower alluvial valley from vicinity of Cairo to the Gulf of Mexico, in 8 sheets, scale 1 inch to 5 miles; first published in 1887, republished with additional data in 1899.

A map of the valley of the Mississippi River from Cairo, Ill., to St. Paul, Minn., in 4 sheets, scale 1 inch to 5 miles; published in 1899.

A district map of the Mississippi River from Cairo to the Gulf of Mexico, showing limits of improvement districts and levee districts, in 1 sheet, scale 1 inch to 5 miles, was published in 1897.

Detail charts, scale 1:20000, showing the hydrography and adjacent topography of the river from the Head of the Passes to Newport, Minn., near St. Paul, a distance of 1,926 miles, in 170 sheets, have been published. Three more sheets, now ready for the printer, will complete this series to include Minneapolis, Minn.

Maps of the river on a scale of 1 inch to 1 mile, in 62 sheets, from the Gulf of Mexico to above Trempealeau, Wis., have been published. Five more sheets are required to complete this series to St. Paul, Minn. Sheets 13-25, inclusive, of this series were reprinted in 1900, showing in red the latest shore lines, controlling levees, new landings, etc., from Rosedale, Miss., to below Baton Rouge, La. As the number of sheets on hand of the old edition is limited, sheet No. 8 being out of print and the supply of the others rapidly diminishing, due to the free issue, it is recommended that a resurvey of the river between the high-water banks be made from Cairo to the mouth of the Arkansas River and that the information thus obtained be printed on the new edition.

Under a recent ruling of the War Department these maps and charts may be issued free under the following regulations:

"1. The secretary of the Mississippi River Commission may issue, free of charge, copies of any or all surplus maps and charts to the following-named persons upon their application: Heads of departments; members of Congress; Government officials, in the performance of whose duties the maps or charts may be beneficial; educational institutions; public libraries; individuals or organized bodies interested in the study of physical data, the development of navigation, or in any work carried on by the Commission; scientific bodies; engineers engaged in the prosecution or study of works of hydraulic engineering.

"2. There may be issued, free of charge, for use on, and to be used on any boat navigating the Mississippi River, such of the 1 inch to the mile charts as will cover the reach of the river on which the boat is operated; application to be made by the person controlling the boat.

"3. In cases other than those mentioned, when application is made, it will be referred by the secretary of the Commission with his recommendation to the president; if approved by him the issue may be made free of charge.

"4. The above free issue will be made judiciously, and the number of charts, maps, or sets of maps or charts issued to any individual or association of individuals will be carefully limited to their probable real needs."

Gauges.—The permanent gauges, high-water gauges, and tide gauges have been maintained during the year.

All of the permanent gauges have been inspected during the recent low-water season, and gauges and bulletins repaired and left in good order. These gauges comprise 17 established by the Commission and 21 received by transfer from the United States Engineer office at Vicksburg, Miss., February 11, 1901. They are distributed on the main river and tributaries as follows: Twenty-five on the Mississippi River; 1 at head of Atchafalaya; 1 each on the Arkansas, Cumberland, Tennessee, and St. Francis rivers; 3 on the Red River; 3 on the Ohio River, including Cairo; 2 on the White River; a total of 38.

A staff gauge was established at Aitkin, Minn., on April 21, 1902, and will be maintained until the survey above Minneapolis is completed. It is not included in the list of gauges given in the preceding paragraph.

The highest and lowest readings on the permanent gauges during 1901 are given in Table No. 2, together with the previous highest and lowest for comparison. A hydrograph showing the stages of the main river from Cairo to Fort Jackson, June 1, 1901, to May 31, 1902, is given on plate 1. The highest readings of 1902 to May 31 are given in Table No. 3.

High-water gauges.—The high-water gauges, of which there are about 182, are on the main river about 5 miles apart between Cairo, Ill., and Fort Jackson, La. These gauges are read at times of the highest water and supplement the regular gauges in determining the high-water profile of the river. These gauges were inspected and repaired by the regular gauge-inspection party on the steamer *Patrol* during October to December, 1901.

The maximum readings on the gauges during the high water of 1901 are given in Table No. 4. The profile of the river platted from these readings is shown on plate 2. This high water was only a moderate one and of short duration. The lower tributaries being at comparatively low stages as the crest passed down the main river, it produced only a very moderate stage in the lower river. The high water of 1902, as shown by Table No. 4, before referred to, while attaining a height of 1.06 feet less than 1901 at Cairo, yet attained a height of 1.5 greater than 1901 at Red River Landing on account of heavy rains and increments from the lower tributaries before the upper river rise had entirely passed the mouth of Red River.

Tide gauges.—The tide gauges at Biloxi, Miss., and East Bay, La., were partially destroyed by the severe storm on the Gulf of Mexico which occurred on August 14, 1901. The Biloxi gauge house and its contents, comprising the automatic tide gauge and an incomplete tide roll, were swept away and lost, as was also part of the staff micrometer. The gauge house at East Bay, which was more sheltered from the storm, was partly displaced, and the instrument and tide roll were saved. The staff gauges at both stations remained in position. A new tide gauge was procured as soon as possible for Biloxi, and new staff micrometer was made for East Bay, and that for Biloxi was repaired. New gauge houses were constructed, and the self-registering gauges installed. The observations were resumed at East Bay on October 12 and at Biloxi on October 22.

The new gauge for Biloxi was made with a new device for automatically recording the time every hour by means of two steel points. Two photographic views of the gauge are given on plate 3. This gauge was made under direction of this office by Hugo Bilgram, of Philadelphia, Pa., and is based upon the Coast Survey model of the Stierle gauge.

Discharge observations.—Low-water discharges of the Mississippi River at Columbus, Ky., Helena, Ark., and Arkansas City, Ark., were measured in November, 1901, by a party on the small steamer *Mercury*, as the river had reached a low stage, 3.2 feet on the gauge at Cairo. The observations were made with double floats and with the Haskell current meter. The results of the final reduction are given in Table No. 6.

The measurement of the high and low water discharges on the Mississippi River and its tributaries is now governed by the following resolutions of the Commission, passed November 13, 1901:

"That the secretary shall be charged with the following duties:

"1. High and low water discharge measurements on the Mississippi River and its tributaries at the stations enumerated in the appended tabulation; the high-water discharge at each station to be measured whenever the stage reaches a point at or above the stage designated in the tabulation, and the low-water discharge to be measured whenever the stage reaches a point at or below the stage named in the tabulation."

Locations of discharge stations and stages at which discharge measurements shall be made.

Location of discharge station.	River.	Discharge stages.		Location of gauge.	Extreme stages.			
		For high water.	For low water.		Highest known stage.		Lowest known stage.	
		<i>Feet.</i>	<i>Feet.</i>		<i>Year.</i>	<i>Feet.</i>	<i>Year.</i>	<i>Feet.</i>
Thebes	Mississippi ..	30	3	Cape Girardeau	1892	35.0	1880	0.9
Columbus	do	42	3	Belmont	1883	45.6	1895	.1
Helena	do	45	2	Helena	1897	51.7	1895	-8.0
Arkansas City	do	46	2	Arkansas City	1897	51.9	1895	-8.6
Warrenton	do	47	-1	Vick-burg	1897	52.5	1895	-6.5
Red River Landing	do	44	2	Red River Landing ..	1897	50.2	1895	-.6
Carrollton	do	15	0	Carrollton	1897	19.2	1872	-1.6
<i>Tributaries.</i>								
.....	Tennessee	23	0	Florence	1897	32.2	1878	-.8
.....	Cumberland	42	1	Nashville	1882	55.3	1878	-.4
Little Rock	Arkansas	25	(a)	Little Rock	1892	31.2	1879	-1.0
.....	Yazoo	27	(a)	Yazoo City	1882	36.5	1875	-4.3
Alexandria	Red	32	(a)	Alexandria	1892	38.3	1881	-3.7
Simmesport	Atchafalaya	44	(a)	Red River Landing ..	1897	50.2	1895	-.6
.....	St. Francis ...	38	(a)	St. Louis, Iron Mountain and Southern Bridge gauge.	1897	41.6	1897	.3
Clarendon	White	32	(a)	Clarendon	1890	36.6	1887	4.1
.....	Black	44	(a)	Red River Landing ..	1897	50.2	1895	-.6

a No low-water measurement required.

"The tributary stations not specifically named in the tabulation shall be located at points above the influence of backwater, and no low water discharge measurement shall be made of the tributary streams except the Tennessee and Cumberland.

"Discharge observations shall be made in accordance with instructions approved August 28, 1894, page 174 of Proceedings."

As sections for observations had not been laid out on all the tributaries, high-water discharge sections were selected on the Cumberland and Tennessee rivers and ranges established by a party on the steamer *Patrol* in January, 1902. Sections were also established on the Arkansas River at Little Rock and on the St. Francis River.

As the Cumberland River at Nashville, Tenn., had risen above the prescribed limit, 42 feet on the gauge, a party was sent into the field on the steamer *Patrol*, and in April 5 to 8 the high-water discharge was measured at the section laid out in January, near Rockcastle, Ky., about 50 miles above the mouth. The highest reading on the Nashville gauge was 46.2 feet on April 4. The results of these observations are given in table No. 7.

A series of observations for rating the various wheels of the two Haskell current meters have recently been made in the settling basin of the city water works, near Bissels Point, St. Louis. The results are now being reduced in the office, and will be noticed in the next annual report.

For additional details concerning the gauges and discharge measurements, attention is invited to the report of Assistant Engineer Kivas Tully (Appendix 1 B).

DREDGES AND DREDGING.

Project.—On the 20th of June, 1896, the Mississippi River Commission adopted a project for obtaining and maintaining, by means of dredges, a channel in the Mississippi River below Cairo, with a width of 250 feet and a depth of at least 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of seven hydraulic dredges by the 30th of June, 1900, and for the provisional construction of two others if found necessary.

The building of this plant has formed a very important part of the work of this office, and has involved the preparation of plans and specifications for the dredges themselves, for the necessary large and small tenders, pile sinkers, and other plant. Since the beginning of the construction of this dredging plant many changes have taken place in the method pursued to procure the most efficient and best-designed dredges.

The first dredge was built after plans prepared by the dredging committee, and was in the nature of an experiment. While many changes in this boat were afterwards found necessary, it yet demonstrated beyond a doubt the efficiency of such hydraulic dredges for the purpose for which it was designed.

The next step was to define, in general terms, the conditions which the dredges must fulfill, leaving to the builders the details of the design. Following this course three dredges were built. Experience was constantly gained until a point was reached where it was possible to outline with greater accuracy nearly all the details of construction. Under such specifications two more dredges were built. Under still more rigidly drawn specifications, another, the seventh, a self-propelling dredge, was placed under contract in 1898. This dredge was completed and delivered to the United States in August, 1900. The eighth and ninth dredges, also self-propelling, were placed under contract in June, 1899, and were completed and delivered to the United States in July, 1901.

CONSTRUCTION, ALTERATION, AND REPAIRS TO PLANT.

Dredge Alpha.—The *Alpha* has been hauled out on the bank; its hull has been condemned, and the boilers and machinery have been stored for future use. The question of building a new hull has not been decided.

Dredge Beta.—At the date of the last annual report the *Beta*, with the tender *Sachem*, was in the charge of the engineer officer at New Orleans, La., engaged in deepening the South Pass of the Mississippi River. It returned to the Government fleet at West Memphis, Ark., on July 27, 1901, and immediately afterwards was sent into the field at Island 34. After the low-water season the main-pump casings were found to be so badly worn that it was necessary to rebore them. This was done with the pumps in place by attaching tools to the runner blades and turning the shaft by a small engine. New wearing plates for the edges of the runners have been obtained. New grate bars for the rocking grates were procured for the boilers. These grates were originally installed in 1900, and were burned out in three seasons, considering the time at South Pass as a season; but they are considered to have paid for themselves, as

the firing is made easier and the steam production increased. The cast-iron frames of the hauling winches were broken during the dredging season, and have been replaced with steel-plate frames, each frame forming a rectangular box properly braced and stiffened. Orders were received April 1, 1901, to prepare the *Beta* for service again at South Pass, should shoaling develop. On May 6, 1901, the officer in charge there requested that the *Beta* be sent, and on May 12 the boat left West Memphis in tow of the *Sachem*. At the date of this report the *Beta* is still engaged upon that work.

Dredge Gamma.—The remodeling of the suction head to permit dredging to a depth of 20 feet was finished. The new pump liners, made of cast iron, cast against a chill, which were put in place at the beginning of the season, did not have to be replaced after the season's work at Lake Providence, La. In the last annual report the rapidity with which the former cast-iron liners were worn through was shown, and it was stated that it was hoped the harder surfaces given would lengthen the life. New edge plates for the runners were required. A steam heating system to replace the stoves was installed.

Dredge Delta.—This dredge was not put in commission during the year, but remained at the fleet, where the alterations to the suction head were in progress. The sides of the suction well were lengthened and a new head block put in place. This change was required, as the new suction head will excavate to a depth of 20 feet, and will work both upstream and while dropping downstream. The new suction head has been received and placed in position. The new jet pumps have been installed as the cutters have been abandoned. The outside of the hull above and below the water line to the knuckle has been sand-blasted and painted by means of a side dock.

Dredge Epsilon.—The side plates on the runners of the main pump forming the inclosed runner had to be renewed, as they were warped when originally put in place. No repairs were necessary to the casing liners. The boilers on this dredge have given trouble by bagging and burned sheets. Four sheets are now being replaced and the position of the forward mud drums changed to the bridge wall, as it is thought the trouble was due to their being too far to the rear.

Dredge Zeta.—New wearing plates for the edge of the runners of the main pumps and new steel plate liners for the casings were required. During the next lay-up period it is expected to inclose the runners as they are done on the dredge *Epsilon*. Two new sheets have to be placed in the boilers and the mud drums changed, as was required in the case of the sister boat *Epsilon*.

Dredge Iota.—New wearing plates for the runner blades have been procured. The iron casting in the port suction pipe, just inside the hull, which was broken during the season's work, has been replaced with a steel casting. The suction head was subjected to severe treatment while at work, owing to logs and drift encountered. The bottom plating of the port suction head for about 3 feet from the mouth was peeled back, the tee in the jet pipe was broken, and the header pipe bent. Repairs were temporarily made in the field. Extensive alterations to the suction head are now under way. The two portions of the head will be rigidly joined together by angles and plates along the top and back of the baffle plates by steel castings as filling plates between the heads, and by a girder at the rear connecting the suction pipes just outside the swivel joints to the hull. The jet-pipe system is also being overhauled. The flexible rubber joint connection to the hull will be replaced by a swivel joint with cast-iron casing, bronze stuffing boxes and steel pipe. The jet-pipe headers will be changed from iron pipe to steel castings bolted through flanges to the under side of the suction head. By this arrangement additional strength is given to the suction head. For handling hydraulic piles a derrick 43 feet high will be erected at each side of the suction well.

Dredges Kappa and Henry Flad.—These two self-propelling dredges are similar to the *Iota*. The main difference is in the pump, which is the inclosed type of runner, with rectangular casing. After the season's work no repairs were required for the pumps. The suction heads and jet-pipe system will be changed as on the *Iota*, and derricks will be erected for handling piles. Winches for hoisting the suction head were not originally on these boats, but now that they have been ordered the suction heads and hoisting arrangements will be the same on the three self-propelling dredges.

Large tenders.—No important alteration or repair has been made. While acting as tender to the dredge *Zeta*, the upper works of the steamer *Wynoka* were completely destroyed by fire October 15, 1901. The steel hull prevented the loss of the machinery. The damage to the hull, boilers, engines, and ice plant was small. The electric-light plant was destroyed, with the exception of the engine. The piping and valves were so much damaged as to be entirely worthless. The hull was towed to the fleet, where it and the machinery have been cared for. As the *Wynoka* will not be rebuilt in time for the coming season's work, the steamer *Minnetonka* will receive slight repairs to the

deck and guards and be used as a tender. The *Leota* did not go into the field during the year. Its refrigerating plant furnished ice to the employees of the fleet during the dredging season.

Steamer Search.—This boat is used as an inspection boat by the superintendent of dredging. A new electric-light plant has been installed and repairs are in progress to the hull.

Small tenders.—Three of these small boats were used as survey boats with the dredges, and one acted as tender to the boats left at the fleet. The boiler on the *Mercury* has been turned around and additional cabin room secured.

Pile sinkers.—Repairs necessary to keep these boats serviceable have been made.

For additional details, attention is invited to the reports of Assistant Engineer C. W. Sturtevant (Appendix 1 C) and Assistant Engineer F. B. Maltby (Appendix 1 D).

DREDGING OPERATIONS ON THE LOWER MISSISSIPPI RIVER BETWEEN CAIRO, ILL., AND HEAD OF THE PASSES.

These operations include the care and repair of plant, testing of dredges, and operation of the plant during the low-water season.

A statement of the general principles which have governed the general conduct of dredging operations may be found in the Report of the Chief of Engineers, United States Army, for 1898, pages 3166-3169, and in the Report of the Chief of Engineers, United States Army, for 1900, page 4564.

During the low-water season of 1900 6 dredges were used for deepening the channels. The *Delta* was not put in commission, owing to the alteration in progress on its suction head. The *Gamma* was held at first in reserve. The river was divided into three districts, and 2 dredges and 1 survey boat assigned to each district. The first district extended from Cairo (0) to Miss Hickman's crossing (131). In it were the *Epsilon* and *Iota*. The uppermost point where work was done was at Joe Eckles crossing (93). The second district extended from Miss Hickman's crossing to Random Shot crossing (192). In it were the *Zeta* and *Beta*. The third district extended from Random Shot crossing as far down as might be necessary. In it were the *Kappa* and *Henry Flad*. The lowest point where work was done was at Peters Towhead crossing (270). Later in the season the *Gamma* was transferred to the officer in charge of the third district. The locations for the channels to be dredged were fixed after careful surveys of each bar where dredging was done. The results obtained were also developed by surveys made during and after dredging. The entire stretch of river covered by dredging operations was constantly patrolled and a careful record was kept of the depths found on the crossings. All possible publicity was given to the information thus obtained; easily distinguishable marks were used to locate the dredged channels and natural channels which developed during the season.

Dredge Beta.—The preliminary reconnaissance having shown that the greatest amount of work at one locality would be in the vicinity of Island 34 (178), and that shoaling was likely to develop there first, the *Beta* (the dredge of largest capacity) left the dredge fleet on August 4 and began work at Hatchie Island crossing (181) August 10, the least depth over the bar being 9½ feet. Dredging was continued until August 18, when a rise in the river caused operations to cease. Work was carried on during September 10-15 at Hatchie Island crossing and during September 15-22 at Hatchie River crossing (180), when the dredge was anchored near the channel to await a lower stage of the river. On October 6 dredging was resumed at Hatchie River crossing and finished October 9. On October 11 it was resumed at Hatchie Island crossing and finished October 14. On November 5 the dredge was moved up to Hatchie River crossing and dredged from November 6 until November 10, with minor delays caused by shortage of labor and by drift. On November 11 the dredge was moved to Morgans Point crossing (182) and worked from November 13 until November 15. The boat left Morgans Point on November 24 and arrived at the dredge fleet for winter quarters at West Memphis, Ark. (232), on November 25.

Dredge Epsilon.—The *Epsilon* left the fleet August 14 and was anchored at Hathaways crossing (103) on August 18. The river had begun to rise and dredging was not required, but to test the condition of the plant dredging was carried on for a day and a half. On September 11 the first real work was done and continued until September 15. The next day the boat was moved to Reelfoot crossing (99) and commenced dredging in the outside channel. Work was finished September 20. Work was resumed October 7 and finished October 14. Another rise and fall in the river having intervened, dredging was carried on at Reelfoot November 7-15, three days being lost by bagged boilers. On November 15 the dredge was moved to Joe

Eckles crossing (93), where it worked until November 18. As a good channel had been formed, it was taken back to Reelfoot, where it dredged for the fourth and last time November 25-29. On December 5 the boat left for West Memphis, and on the next day was put out of commission.

Dredge Zeta.—The *Zeta* left the fleet August 9 and arrived at Plum Point (163) August 10. It dredged at Plum Point (or Island 30) crossing three different times—August 13-18, September 15-18, and October 7-12. A slight shoaling having developed at O'Donnell's crossing (149), the dredge was moved there and worked from October 13 until October 15. While there the steamer *Wynoka*, tender to the *Zeta*, caught fire and the upper works were destroyed. In November, after a long, steady decline of the river, shoal places developed at localities that had hitherto given no trouble, and the *Zeta* worked at two of these—Gold Dust crossing (158), November 8-12, and Last Chance crossing (166), November 13-16. On November 20 the boat departed for West Memphis, reaching there November 21.

Dredge Iota.—The *Iota* left the fleet August 7 and reached Booths Point crossing (120) August 11. The next day dredging was begun, but owing to delay caused by attempting to use mushroom anchors for head piles and damage done to the port suction pipe, little was accomplished, and as the river was rising work was discontinued August 15. The first work was begun September 11 and completed September 20. The second and last dredging at this point was carried on October 5-13. The *Iota* was then moved to Hathaway's crossing (103), where the *Epsilon* had previously been at work. Dredging was carried on there October 14-17 and November 7-9, the latter time at the extreme lower end. The dredge was next taken to Miss Hickman's crossing (131), where it worked November 12-13, and to Plum Point crossing (163), where it worked November 20-22 at the locality where the *Zeta* had previously dredged. The last work done during the season was at Hatchie Island crossing (181), November 27 to December 1, after the *Beta* had returned to West Memphis. On December 4 the *Iota* left to go into winter quarters and arrived at the fleet the same day.

Dredge Kappa.—The *Kappa* left the fleet August 12 for Presidents Island (234), where all its season's work was done with the exception of a small amount of dredging at Graves Bayou crossing (250), November 4-6. The first period at Presidents Island extended from August 12 until August 21, the work being delayed by the use of the mushroom anchors. The second period was from September 9 to September 21, the third from October 7 to October 18, and the fourth and last from November 17 to November 21. The *Kappa* then rejoined the fleet at West Memphis.

Dredge Henry Flad.—The *Henry Flad* did not leave the fleet until September 19, when it was sent to Peters Towhead crossing (270) and dredged from September 20 to September 23. On September 25 it was moved to Polk's crossing (266), and after the river had fallen dredging was carried on from October 5 to October 12. On November 1 the boat was returned to Peters Towhead crossing, where it dredged from November 2 until November 12 at the upper reef, at the lower reef, and at Peters upper crossing (269), the work being delayed by repairs to machinery. The dredge was then moved to Star crossing (260) and dredged November 12-20, the time from November 16 to November 20 being spent in removing lumps formed by the discharge pipe in the lower part of the dredged channel. Work was resumed November 25 and finished November 26, when the boat departed for West Memphis, where it went into winter quarters the next day.

Dredge Gamma.—In obedience to instructions from the president of the Mississippi River Commission, the *Gamma*, in tow of the tender *Choctaw*, left the fleet October 17 for Lake Providence, Louisiana (543), to dredge at Stack Island bar under the orders of the engineer officer in charge of the Third district. The object of the work was to cut through the point of the sand bar opposite the revetment work at Lake Providence and to induce the current to follow that cut, thereby removing the pressure from the revetment. Dredging began October 23 and was completed December 1. On December 4 the *Gamma* departed for West Memphis, arriving there December 19.

A summary of the dredging operations, distribution of time, and expenditures will be found in Tables Nos. 8 and 9. For further details, attention is invited to the report of Assistant Engineer C. W. Sturtevant (Appendix 1 C).

DISCUSSION OF RESULTS.

Referring to the hydrograph on plate 1, it will be seen that the season was one demanding the dredges to keep open the channel. At the first of August the river was falling, being 10 feet on the Cairo gauge. The dredges were put into the field and were operated until a rise in the river, the middle of August, which reached on August 27 the height of 25.1 feet on the Cairo gauge. As the river declined the

dredged channels began to fill, and dredging was resumed September 10, to be interrupted by another rise to 15.5 feet on the Cairo gauge. From the first of October to the last of November the river was falling, and it was practically at a stand after the middle of November. The lowest stage reached at Cairo was 2.88 feet on November 28. The lowest stage reached at Memphis was -0.3 foot on December 1. These fluctuations and the stand in November are shown by the following gauge readings:

CAIRO.

Date.	Reading.	Date.	Reading.
	<i>Feet.</i>		<i>Feet.</i>
August 12.....	6.6	October 10.....	6.3
August 27.....	25.1	November 1.....	4.4
September 16.....	8.8	November 15.....	3.1
September 25.....	15.5	November 28.....	2.88

MEMPHIS.

Date.	Reading.	Date.	Reading.
	<i>Feet.</i>		<i>Feet.</i>
August 14.....	3.0	October 10.....	2.6
August 29.....	16.7	November 1.....	1.2
September 18.....	4.4	November 15.....	.1
September 28.....	8.5	December 1.....	-.3

During the long low stage it was generally necessary to dredge twice at the troublesome crossings, but the amount to be done was small. Other shoal crossings developed, but they were quickly deepened. At no time was there less than 9 feet at any crossing. River men said they had never seen so much water in the river at such a low stage. The dredges were over a month longer in the field than in 1900, as low water came two months later and was over 2 feet lower on the Memphis gauge. As the channels were maintaining themselves well, about November 20 the dredges were gradually withdrawn, one being taken from each district, until by December 6 all were at the fleet. Of the entire time that the dredges were in commission, 66.4 per cent was passed not working, waiting for lower stage. In this long low-water season 6 dredges were able to keep the channel open. Evidently, with the 8 dredges belonging to the Commission, nothing need be feared concerning the maintenance of its project.

The results of the dredging operations are shown on plates 4 to 65, to which attention is respectfully invited. All soundings on these plates are reduced to mean low water, and depths greater than 9 feet below mean low water are indicated by parallel ruling. It must be remembered that the depths given are not the actual depths existing at the time of the survey. The plates illustrating the dredging operations are believed to show clearly what was accomplished and to indicate the general rules which governed the location of the dredged cuts. The first plate of the series gives the total dredged area for the season. The plate showing the result of the first dredging gives the area dredged the first time only. After each subsequent dredging the new area dredged is added to the area already shown. Owing to the number of localities where dredging was done, 18 in all, the results at each locality are not shown, the principal ones being selected. Below will be found a brief discussion of the results obtained at each locality where dredging was done.

Joe Eckles Crossing (93)—Plates 4-6.—This was one of the localities requiring dredging the middle of November, after the long, steady fall of the river. As shown on plate 4, a neck 200 feet long between the 9-foot contours had to be cut through. This the *Epsilon* accomplished in seventy-two hours. Plate 6, ten days after dredging, shows a better channel than plate 5, five days after.

Reelfoot Crossing (99)—Plates 7-16.—This locality was one of the most troublesome of the season. Dredging had never been required there before. On plate 7 the two deep pools to be connected by dredging are shown. The line selected was 2,000 feet long, and was chosen rather than a shorter line to a point higher up on the left bank because, being straighter, it obviated the two short turns which a boat would have to make on the alternative line, and because, as deeper water was found along this line, it was expected the river would assist in deepening. Plate 8 shows

the condition after the first dredging. The work was interrupted by rising water, the least depth being 15½ feet. Plate 9 shows the development of the middle ground between the dredged channel and the lower pool and the reaching out of the lower pool toward the cut. In the second dredging (pl. 10) it was not necessary to make such a long cut, only to widen it in the middle. This plate, showing the survey two days after dredging, indicates shoaling at the lower end, where it is always expected, but on plate 11 it had washed out. Plate 12 shows the progressive deterioration, and it became necessary to dredge the third time (pl. 13) over practically the same area. Plates 14 and 15 show the 9-foot contour all the way through the cut, but as the channel was narrowing at the lower end the dredge was put to work the fourth time (pl. 16), and a deep, broad channel was formed, 350 feet wide.

Hathaways Crossing (103).—Plates 17–22.—From plate 17 it is seen that two overlapping pools have to be connected, and the problem is the same as at Reelfoot Crossing. The prolongation of the upper pool is selected as before, thereby tapping this pool as far down as possible. The first dredging was interrupted by rising river. Plates 18 and 19 show the conditions after this dredging. The line of the second dredging (pl. 20) was changed to follow the downstream prolongation of the upper pool. Plate 21 shows shoaling and a very narrow channel at the lower end, necessitating further work (plate 22) at this end only, November 7–9. The channel remained good the rest of the low-water season—about three weeks.

Booths Point Crossing (120)—Plates 23–27.—The conditions at this locality were the same as last season—a shoal extending down and across the river and separating the lower pool into two forks. From a study of the conditions on the ground it was apparent that the channel tended to the lower fork, and, as before, the long and straight line was selected (pl. 23). A good straight channel was obtained (pl. 24), which continued to maintain itself (pl. 25), but as it was growing narrow it was dredged again and widened (pl. 26). This work was completed October 13, and nothing further was required. Plate 27 shows the channel twenty-two days after the final dredging.

Miss Hickmans Crossing (131).—The *Iota* dredged here on November 12 and 13, where a short reef had to be cut through. The 9-foot contours were within 150 feet of each other, with 9½ feet the mid-channel depth. Survey seven days after dredging shows an 11-foot channel 275 feet wide and a 9-foot channel 400 feet wide.

O' Donnell's Crossing (149).—The channel at this point had the requisite depth, and the *Zeta* widened it October 14–15, making a cut 2 feet deep.

Gold Dust Crossing (158).—The channel was gradually shoaling, and a long cut, nearly 2,400 feet long and 200 feet wide, was made. A channel 200 feet wide with a 13-foot depth, and 325 feet wide with a 9-foot depth, was formed.

Plum Point Crossing (163).—Plates 28–37.—The dredging at this place covered nearly the same area as in the season of 1900 at the place called Foot of Island 30 Crossing (165), but dredging was required four different times, instead of the single time of last season. There was a broad, flat channel (Pl. 28) between the bar at the foot of Island 30 and Osceola Bar, 4,000 feet apart, with two main crossings, the upper leading to the deep pool by Plum Point, the steamboat landing, and the lower to the pool by Osceola Bar. The upper crossing was chosen. After the first dredging a heavy rise in the river followed. Plate 29 shows the effect of the rise. The entire channel was over 9 feet deep, and a decided tendency existed for the main crossing to be much lower down, which would cause the abandonment of the dredged channel. However, in plates 30 and 31 a recurrence to the original conditions is manifested, the lower crossing being encroached upon and the shoal extending to the dredged area, necessitating dredging the second time September 15, eighteen days after the passage of the crest of the rise. Plate 32 shows the location of this cut, north of the first and farther away from the encroaching shoal to the south. Another rise in the river followed, and plate 33 shows the conditions four days after the passage of the crest. Dredging became necessary the third time October 7 (pls. 34–35). The lower crossing had become obliterated and shoals were coming down from the north. The cut was extended upstream to get into deep water (pl. 36). The channel maintained itself well for a month, but required dredging the fourth time to widen it on the lower side (pl. 37).

Last Chance Crossing (166).—Where the channel, leaving the Tennessee shore below Plum Point, crosses to the Arkansas shore, the crossing was broad and flat. About the middle of November the crossing was deepened by dredging, forming a channel 13 feet deep and 200 feet wide; the 9-foot channel was 300 feet wide.

Hatchie River Crossing (180).—Plates 38–43.—The conditions of this locality were about the same as the preceding two years. Plates 38 and 39 show the deterioration in the channel. The results of the first dredging and the September rise are shown in plates 40 and 41. Dredging was necessary a second time in October to keep the

channel open (pls. 42-43). A month later the *Beta* dredged in the same place, forming a 9-foot channel 250 feet wide, which remained open the rest of the season.

Hatchie Island Crossing (181).—Plates 44-55.—This was one of the big pieces of work and the locality where shoal water first developed. Referring to plate 44, it is seen that a channel 1,500 feet long had to be cut between the 9-foot contours. The lower pool in front of Mill Point was deep and permanent, and hence the cut would not have to be extended downstream, but extensions were continually required into the flat, shallow basin above until the cut was 2,800 feet long. Plate 45 shows a deep, narrow channel after the first dredging. After the next rise (pl. 46), the upper pool extended with almost its full width to the lower, but plate 47 shows that the condition was temporary, and dredging was resorted to the second time to widen the channel (pls. 48-49). The lump shown in plate 49 does not exist in plate 50. Other shoal places appearing later (pl. 52), the channel was dredged the third time. Nothing more was required from October 14 to November 27, when the dredging was extended upstream and a shallow cut made over the whole area (pl. 55).

Morgans Point Crossing (182).—During the extreme low-water season a little work was required there. A 9-foot channel 325 feet wide was formed.

Presidents Island Crossing (234).—Plates 56-63.—Of the two possible channels, above and below the neck, the lower and direct one was selected (pl. 56). Plate 57 shows the first cut. During the second dredging the cut had to be extended at both ends. Plate 59 shows deep water in both channels, but plates 60 and 61 show that the upper channel was not permanent, and also that the lower channel had shifted out of the cut. The last work was in deepening this new channel (pls. 62-63). This is the only instance in the season's work of the channels leaving the dredged area. The movement was lateral and for only a short distance.

Graves Bayou (250).—A small amount of work was done at this locality in November. A 10-foot channel 750 feet wide was formed.

Star Crossing (260).—This wide crossing required attention in November, and an 11-foot channel 200 feet wide was formed.

Polks Crossing (266).—Plate 64.—As this was a broad channel, shoaling was feared, and a dredge worked there October 5-12. Plate 64, eighteen days after dredging, shows how well the channel maintained itself.

Peters Upper Crossing (269).—This locality was dredged in November.

Peters Towhead Crossing (270).—Plate 65.—The first dredging was at the upper end, in September. In November dredging was required again at the upper end and at the lower reef.

No dredging was done at Point Pleasant (81), which has hitherto been the most troublesome locality and required attention every season. Fleeces Crossing (243), which has hitherto been a bad place, gave no trouble. Dredging has not been necessary at Island 40 (213) since 1898. At Booths Point Crossing, Plum Point Crossing, Hatchie River Crossing, and Presidents Island, important points this season, the conditions were about the same as last year.

To form an estimate of the amount of material actually moved by the dredges, the same assumptions were made as in previous years—that the width of each cut is equal to the width of the dredge's suction, that the depth is determined by actual soundings, and that the side slopes are 1 on 2½. The result of this calculation is 1,666,465 cubic yards. In 1900 the amount was 1,145,599 cubic yards; in 1899, 1,612,223 cubic yards.

For additional details attention is invited to the report of Assistant Engineer C. W. Sturtevant. (Appendix 1 C.)

SELF-PROPELLING DREDGES.

Two new self-propelling dredges, *Kappa* and *Henry Flad*, were received from the contractors, The Bucyrus Company, South Milwaukee, Wis., this season, and, after a trial on the sand bar at the dredge fleet, were accepted and used during the season.

Pipe lines.—The pipe lines for these dredges were bought under separate contract, and as they were not delivered until February of this year, each dredge used last season 600 feet of floating pipe borrowed from the *Della*, which was not in commission, and the *Beta*. The new line will be 480 feet long, consisting of eight pontoons and eight lengths of pipe 32 inches inside diameter and 60 feet long. The pontoons are designed to support the pipes, even when the latter are filled full of wet sand, and are keel boats, elliptical in plan, 36 feet long, 20 feet wide at the middle, and 42 inches deep from base line to gunwale. When the pipes are loaded the pontoons will have 6 inches freeboard. Instead of connecting the lengths of the pipe line with flexible rubber joints there will be one or three universal couplings in the line, and the other lengths will be bolted together with steel flanges, forming rigid sections 240 or 120

feet long. The coupling forms a ball-and-socket joint, giving motion in all directions, and will allow for the wave action on the river. It will be noted that the pipe line is 480 feet long instead of 1,000 feet, as in the earlier dredges. This reduction is allowable, as a rudder is attached to each ponton, and by setting the rudders at an angle with the current the line can be swung to one side and the material deposited out of the channel. The *Iota* is equipped with this line, and no trouble has been experienced in deflecting it, in one case as far as 60° from the axis of the channel.

Sinking anchors.—Pile sinkers are not used with the self-propelling dredges. Efforts were made at first to discard the hydraulic pile and substitute a mushroom anchor jetted down from the dredge. Anchors 24 and 30 inches in diameter were tried, but it was difficult to obtain sufficient penetration to keep them down when the strain was placed on the hauling line. A temporary derrick was then erected on the bow of the dredge and hydraulic piles were sunk from it in the usual manner. This gave complete satisfaction and was used the balance of the season. Permanent derricks are being placed on the dredges now, strong enough to assist also in removing snags encountered. Experiments will be continued with the mushroom anchors.

Advantages.—The *Iota* has been operated two seasons and the *Kappa* and *Henry Flad* one season, and it is conclusively demonstrated that self-propelling dredges are a success. They are more economical, as the tender and pile sinker are eliminated, and the crew reduced from 60 to 45. They can easily handle themselves and their tow with an upstream speed of about 2 miles per hour. No difficulty is experienced in supplying the self-propelling dredges with coal. With proper management a dredge should never have occasion to leave a channel to pick up a fuel barge.

CENTRIFUGAL PUMPS.

The latest form of pump placed on the *Kappa* and *Henry Flad* has a rectangular casing and an inclosed runner. A steel ring is riveted to each side of the blades. The casing is machined on the inside as far as the periphery of the runner and lined with steel plate. Beyond the center liners the side liners are cast iron, and the shell is lined with steel plate. The clearance between runners and liners at the beginning of the season was three-sixteenths inch. The object of this type is to reduce the wear, which increases the clearance and decreases the efficiency of the pump, and also to enable new liners to be easily put in. The *Kappa* worked at Presidents Island on a coarse gravel bar which heretofore has worn very badly the pumps. In the preceding year the *Gamma* repeatedly wore out a set of 14-inch cast-iron liners in from twelve to twenty-four hours' work. The *Kappa's* liners and side rings showed almost no wear, and no repairs were necessary after the season's work.

In the older pumps the wearing plates on the blades are being made of cast steel, the face of which is cast against a chill, leaving the back soft enough to be drilled. The casing liners are of steel plate.

The following papers accompany this report:

Money statements.

Abstracts of contracts in force.

Commercial statistics.

Statement of charts issued and sold.

Appendix 1 A, Laws affecting the Mississippi River Commission, July 1, 1901, to June 30, 1902.

Appendix 1 B, Report of Assistant Engineer Kivas Tully on gauges, discharge observations, reduction of physical data, and office publications.

Appendix 1 C, Report of Assistant Engineer C. W. Sturtevant on dredging operations on the Mississippi River between Head of the Passes and mouth of the Ohio River, and care and repair of dredging plant to include December 31, 1901.

Appendix 1 D, Report of Assistant Engineer F. B. Maltby on care and repair of dredging plant since January 1, 1902.

Table 1. Low-water slope, Mississippi River, Aitkin, Minn., to Minneapolis, Minn., 1901.

Table 2. Highest and lowest gauge readings in 1901, Mississippi River and tributaries.

Table 3. Highest gauge readings in 1902 to May 31, Mississippi River and tributaries.

Table 4. Maximum readings of high-water gauges, Mississippi River, Cairo, Ill., to Fort Jackson, La., 1901.

Table 5. Low-water slope, Mississippi River, Cairo, Ill., to Fort Jackson, La., 1901.

Table 6. Results of discharge observations, Mississippi River, low water, 1901.

Table 7. Results of discharge observations, Cumberland River, high water, 1902.

Table 8. Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1901.

Table 9. Cost of dredging operations, April 1, 1901, to March 31, 1902.

Table 10. Depths over shoal crossings, Mississippi River, Cairo, Ill., to Vicksburg, Miss., low-water season of 1901.

Plate 1. Hydrograph of Mississippi River, Cairo, Ill., to Fort Jackson, La., June 1, 1901, to May 31, 1902.

Plate 2. Profiles Mississippi River, high and low waters 1901, Cairo, Ill., to Fort Jackson, La.

Plate 3. Self-registering tide gauge.

Plates 4-65. Maps of certain localities on the Mississippi River below mouth of the Ohio River where dredging was done during low-water season of 1901, as follows: 4-6, Joe Eckles's crossing; 7-16, Reelfoot crossing; 17-22, Hathaway's crossing; 23-27, Booth's crossing; 28-37, Plum Point crossing; 38-43, Hatchie River crossing; 44-55, Hatchie Island crossing; 56-63, Presidents Island crossing; 64, Polk's crossing; 65, Peters Towhead crossing.

Respectfully submitted.

G. P. HOWELL,

Captain, Corps of Engineers, Secretary Mississippi River Commission.

To the PRESIDENT MISSISSIPPI RIVER COMMISSION.

Money statements.

APPROPRIATION FOR IMPROVING MISSISSIPPI RIVER.

July 1, 1901, balance unexpended	\$513, 904. 42
Amount allotted from appropriation by sundry civil act approved June 6, 1900.....	6, 500. 00
	<hr/> 520, 404. 42
June 30, 1902, amount expended during fiscal year	\$390, 990. 76
Amount allotted for expenses of office of Chief of Engineers, United States Army, approved by acting Secretary of War, February 25, 1902.....	5, 000. 00
	<hr/> 395, 990. 76
July 1, 1902, balance unexpended.....	124, 413. 66
July 1, 1902, outstanding liabilities	\$30, 109. 89
July 1, 1902, amount covered by uncompleted contracts	43, 265. 10
	<hr/> 73, 374. 99
July 1, 1902, balance available	51, 038. 67

APPROPRIATION FOR GAUGING THE WATERS OF THE LOWER MISSISSIPPI AND ITS TRIBUTARIES.^a

July 1, 1901, balance unexpended	\$728. 24
Amount allotted by Chief of Engineers, July 31, 1901, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal year ending June 30, 1902.....	6, 000. 00
	<hr/> 6, 728. 24
June 30, 1902, amount expended during fiscal year	5, 885. 82
July 1, 1902, balance unexpended.....	842. 42
July 1, 1902, outstanding liabilities	320. 00
July 1, 1902, balance reverting to Treasury	522. 42
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	9, 600. 00.

^a The custody and care of the gauges maintained under this appropriation were assumed by the Mississippi River Commission February 11, 1901, on which date they were transferred to the secretary, under authority of Secretary of War, dated January 25, 1901.

46 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Itemized statement of expenditures during the fiscal year ending June 30, 1902, submitted in compliance with requirement of section 6 of river and harbor act of August 11, 1888.

Observations:		
Pay of permanent gauge observers.....		\$4,320.00
Inspections and repairs:		
Inspection of gauges on Mississippi River by junior engineer and party on steamer	\$1,067.83	
Inspection of gauges on tributaries by junior engineer....	93.60	
Repairs to gauges and bulletins.....	82.83	
		1,244.26
Office expenses and contingencies:		
Pay of assistant and junior engineers	300.00	
Stationery and printing.....	13.32	
Transportation of office records	8.24	
		321.56
		5,885.82

Consolidated statement of appropriations and allotments.

[Appropriation for gauging the waters of the Lower Mississippi and its tributaries.]

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—		
March 3, 1871		\$5,000.00
June 10, 1872		5,000.00
March 3, 1873		5,000.00
June 23, 1874		5,000.00
March 3, 1875		5,000.00
Specific appropriations by river and harbor acts of—		
August 14, 1876		5,000.00
June 18, 1878		5,000.00
March 3, 1879		5,000.00
June 14, 1880		5,000.00
March 3, 1881		5,000.00
August 2, 1882		5,000.00
Deficiency act of March 12, 1884		2,100.00
Specific appropriations by river and harbor acts of—		
July 5, 1884		5,000.00
August 5, 1886		5,000.00
Allotted from specific appropriation by river and harbor act of August 11, 1888		8,700.00
Deficiency act of October 19, 1888		3,600.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:		
1890		9,000.00
1891 (less \$3,518.34 withheld in United States Treasury under ruling that only \$6,000 can be expended each fiscal year)		5,181.66
1892		5,100.00
1893		5,500.00
1894		5,500.00
1895		5,500.00
1896		5,500.00
1897		5,500.00
1898		5,500.00
1899		6,000.00
1900		5,500.00
1901		6,000.00
1902		6,000.00
Total		155,181.66

Expended.

	To June 30, 1901.	During year ending June 30, 1902.	Total.
Expenditures.....	\$141,503.97	\$5,885.82	\$147,389.79
Unexpended balances reverted to Treasury.....	6,949.45	522.42	7,471.87
Total.....	148,453.42	6,408.24	154,861.66
Unexpended balance June 30, 1902.....			320.00
Total appropriated, etc.....			155,181.66

Abstract of contracts entered into by Capt. G. P. Howell, Corps of Engineers, in force June 30, 1902, improving Mississippi River; Mississippi River Commission, secretary's office.

Contract for—	Contractor.	Rate per bush- el.	Date of con- tract.	Date of ap- proval.	Date of beginning work.	Date of ex- piration.
350,000 bush- els coal.	Frederick Hartweg.	\$0.10½	May 1, 1901	June 24, 1901	May 1, 1901	June 30, 1902
300,000 bush- els coal.	The Monongahela River Consolidat- ed Coal and Coke Co.	.11½	Mar. 26, 1902	May 19, 1902	July 1, 1902	June 30, 1903

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1901.

TABLE No. 1.

Tonnage between—	Passen- gers.	Receipts and shipments, in tons.				
		Grain and its products.	Cotton.	Cotton seed.	Live stock.	Coal and coke.
St. Louis and Cairo	60,679	137,954	308		31,981	80,950
Cairo and Memphis.....	44,844	103,599	13,647	21,750	1,903	1,359,462
Memphis and Vicksburg.....	107,669	143,791	49,853	39,855	5,200	1,281,393
Vicksburg and New Orleans.....	82,459	112,314	71,925	60,936	2,954	1,225,970

Tonnage between—	Receipts and shipments, in tons.					Total.
	Lumber.	Logs.	Iron, steel, and metals.	Groceries and pro- visions.	Miscel- laneous and un- classified.	
St. Louis and Cairo	94,704	37,600	29,122	83,656	67,573	563,848
Cairo and Memphis.....	228,493	309,395	55,672	37,340	175,141	2,306,302
Memphis and Vicksburg.....	55,747	129,286	32,851	74,221	44,442	1,856,339
Vicksburg and New Orleans.....	37,359		31,272	154,887	137,567	1,835,174

Each stretch is treated as a separate river, and tonnage carried between ports on different stretches will appear in the statistics of all intervening stretches. Consequently, the sum of the tonnage carried in the four stretches does not give the total traffic on the river.

TABLE No. 2.—*Receipts and shipments at principal ports.*

	Arrivals and departures.		Receipts and shipments, in tons.				
	Number.	Tonnage.	Grain and its products.	Cotton.	Cotton seed.	Live stock.	Coal and coke.
St. Louis, Mo.....	2,647	889,606	144,242	1,213	18	25,426	62,638
Memphis, Tenn.....	(a)	(a)	20,473	30,537	44,573	3,352	62,062
Vicksburg, Miss.....	1,532	279,956	23,661	11,350	14,976	1,386	52,579
New Orleans, La.....	(a)	(a)	1,365,965	1,011,023	94,197	68,169	1,334,352

	Receipts and shipments, in tons.					
	Lumber.	Logs.	Iron, steel, and metals.	Groceries and provisions.	Miscellaneous and unclassified.	Total.
St. Louis, Mo.....	161,112	32,661	2,864	67,867	174,040	672,076
Memphis, Tenn.....	65,800	268,261	13,551	29,004	172,218	709,831
Vicksburg, Miss.....	9,923	67,836	217	21,946	30,374	234,246
New Orleans, La.....	504,224		316,826	1,131,833	1,043,646	6,870,426

a Returns incomplete.

Arrivals and departures at St. Louis include barges, Government boats, etc.

Arrivals and departures at Vicksburg exclude barges, Government boats, etc.

TABLE No. 3.—*Seagoing traffic at New Orleans, La.*

ARRIVALS AND DEPARTURES.

Number	3,346
Tonnage	2,851,899

RECEIPTS AND SHIPMENTS.

	Tons.
Grain and its products.....	1,259,595
Cotton.....	940,582
Cotton seed and its products.....	44,955
Live stock.....	61,266
Coal and coke.....	108,582
Lumber.....	469,379
Iron, steel, and metals.....	285,559
Groceries and provisions.....	977,200
Miscellaneous and unclassified.....	938,454
Total.....	5,085,572

TABLE No. 4.—*Ferry traffic.*

Location of ferries and transfers.	Passengers.	Receipts and shipments, in tons.				
		Grain and its products.	Cotton.	Cotton seed.	Live stock.	Coal and coke.
St. Louis.....	1,827,086					591,349
Cape Girardeau.....	8,825	2,581	1,385		139	30,706
Cairo.....	21,862	19,988			2,252	
Memphis.....	172,190	200	575	950	1,800	25
Helena.....	42,906	3,806	7,876	2,301	213	5,809
Arkansas City.....	5,000			400	106	
Vicksburg.....	73,929		168		2,150	
Natchez.....	50,840			175	400	
Bayou Sara.....	600				160	
Baton Rouge.....	60,000					
Donaldsonville.....	27,475				365	
New Orleans.....	2,989,438	62,839	136,821	76,150	12,599	147,778

TABLE No. 4.—Ferry traffic—Continued.

Location of ferries and transfers.	Receipts and shipments, in tons.					Total.
	Lumber.	Logs.	Iron, steel, and metals.	Groceries and provisions.	Miscellaneous and unclassified.	
St. Louis	425,000	.....	25,000	.....	a 4,870,452	5,911,801
Cape Girardeau	95,975	.....	7,146	.....	b 150,916	150,916
Cairo	1,500	.....	.....	2,676	26,088	52,454
Belmont .....	.....	.....	.....	.....	76,873	76,873
Memphis	100	.....	.....	500	321,651	325,801
He'ena	58,275	.....	273	1,651	16,404	96,608
Arkansas City	1,750	.....	.....	15	10	2,281
Vicksburg	35	.....	.....	.....	301,348	303,721
Natchez .....	.....	.....	.....	.....	1,800	c 2,375
Bayou Sara	175	.....	.....	.....	500	835
Baton Rouge .....	.....	.....	.....	.....	7,200	7,200
Donaldsonville	2,200	.....	.....	490	600	3,655
New Orleans	134,877	.....	80,288	467,566	813,897	1,932,815

a Includes 250,000 tons of sand.

b 50,782 cars transferred, not included.

c Does not include 5,495 cars transferred (4,409 loaded and 1,086 empty).

REMARKS.

Reports were not received from the following vessels: Steamer *Sun*, running in the stretch between Cairo and Memphis; steamers *Helene* and *City of Idaho*, in the stretch between Memphis and Vicksburg; steamer *Chabnette*, in the stretch between Vicksburg and New Orleans.

Statement of maps and charts issued and sold from July 1, 1901, to June 30, 1902.

Description.	Free.	Sold.	Total.
Upper alluvial valley map	60	58	118
Lower alluvial valley map	142	357	499
Inch-to-mile map	878	1,570	2,448
Detail chart, 1:20000 scale	1,873	837	2,710
Detail chart, 1:10000 scale (harbor of New Orleans)	40	28	68
District map of Lower Mississippi River	2	3	5
Total	2,995	2,853	5,848

Proceeds deposited with assistant treasurer of the United States at St. Louis, Mo., \$360.82.

APPENDIX 1 A.

LAWS AFFECTING THE MISSISSIPPI RIVER COMMISSION, JULY 1, 1901, TO JUNE 30, 1902.

[PUBLIC—No. 154.]

AN ACT making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available, and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the construction, completion, repair, and preservation of the public works hereinafter named:

* * * * *

The Secretary of War is hereby directed to maintain the channel in the South Pass of the Mississippi River with the utmost efficiency, and for that purpose the dredge boat Beta, or any other available Government dredge, may be used.

* * * * *

To repair the Government levee heretofore constructed to prevent the cutting through the space dividing the Mississippi and Saint Francis rivers in the vicinity of Walnut Bend, Arkansas, and to extend the same about seven thousand feet to Wheel Ridge, in said State, as recommended by the Chief of Engineers in Senate Executive Document Numbered One hundred and four, Fifty-third Congress, second session, ninety thousand dollars, to be expended under the direction of the Mississippi River Commission.

The sum of two hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated for making such surveys, examinations, and investigations as may be required to determine the feasibility of, and to prepare and report plans and estimates of cost of, a navigable waterway fourteen feet in depth from Lockport, Illinois, by way of the Des Plaines and Illinois rivers, to the mouth of said Illinois River, and from the mouth of the Illinois River, by way of the Mississippi River, to Saint Louis, Missouri: *Provided*, That twenty-five thousand dollars of said sum, or so much thereof as may be necessary, may be expended by the Mississippi River Commission in making surveys, examinations, and investigations herein required from the mouth of the Illinois River to Saint Louis: *Provided further*, That the Secretary of War shall appoint a board of three engineers to make the surveys, examinations, and investigations hereinbefore required from Lockport, Illinois, through the Des Plaines River and Illinois River, to the mouth of said Illinois River, and that all such surveys, examinations, and investigations shall be made to determine the feasibility of, and to prepare and report plans and estimates of cost of, a navigable waterway fourteen feet in depth from Lockport, Illinois, to Saint Louis, Missouri. The said Mississippi River Commission shall make said report covering such proposed improvement from the mouth of the Illinois River to Saint Louis, and the said board of engineers shall make such report from Lockport, Illinois, to the mouth of the Illinois River.

* * * * *

Improving Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries, clerical, official, traveling, and miscellaneous expenses of the Mississippi River Commission: Continuing improvement, two million two hundred thousand dollars, which shall be expended under the direction of the Secretary of War, in accordance with the plans, specifications, and recommendations of the Mississippi River Commission, as approved by the Chief of Engineers, for the general improvement of the river, for the building of levees, and for surveys, including the survey from the Head of the Passes to the headwaters of the river, in such manner as in their opinion shall best improve navigation and promote the interests of commerce at all stages of the river: *Provided*, That on and after the passage of this act additional contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry on continuously the plans of the Mississippi River Commission, as aforesaid, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate six million dollars, exclusive of the amounts herein and heretofore appropriated, which latter amount shall be expended at the rate of two million dollars per annum for three years, beginning July first, nineteen hundred and three: *Provided further*, That the money hereby appropriated and authorized to be expended, in pursuance of contracts, or otherwise, or so much thereof as may be necessary, shall be expended in the construction of suitable and necessary dredge boats and other devices and appliances, and in the maintenance and operation of the same, with a view of ultimately obtaining and maintaining a navigable channel, from Cairo down, not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year, except when navigation is closed by ice: *And provided further*, That of the amounts hereby appropriated and authorized to be expended, the Mississippi River Commission may expend, in its discretion, as approved by the Chief of Engineers, during a period of two years in continuing improvements at New Orleans, Louisiana, Natchez and Vidalia, Mississippi and Louisiana; Memphis, Tennessee, including Wolf River; and the rectification of the Red and Atchafalaya rivers, Louisiana, an amount aggregating two hundred thousand dollars; and in like manner, from said amounts hereby appropriated and authorized, during a period of four years, aggregate amounts for continuing improvements as follows: At Greenville, Mississippi, fifty thousand dollars; at Helena, Arkansas, twenty thousand dollars; at Caruthersville, Missouri, twenty thousand dollars; at New Madrid, Missouri, twenty thousand

dollars. And the Chief of Engineers shall have authority to temporarily remove one or more of the dredges now under the control of the Mississippi River Commission from the river below Cairo to the river from the mouth of the Ohio to and including the mouth of the Missouri, and to so operate the same as, in his judgment, will be most beneficial to the commerce of the whole river, and to expend, from the sum herein appropriated and authorized to be expended for the improvement of the river from the mouth of the Ohio to and including the mouth of the Missouri, for the maintenance and operation of such dredge or dredges from the mouth of the Ohio to and including the mouth of the Missouri, a sum not to exceed fifty thousand dollars per annum for four years.

* * * * *

SEC. 5. That when any land or other property which has been heretofore or may be hereafter purchased or acquired for the improvement of rivers and harbors is no longer needed, or is no longer serviceable, it may be sold in such manner as the Secretary of War may direct, and the proceeds credited to the appropriation for the work for which it was purchased or acquired; and the Secretary of War may direct the transfer of any property employed in river and harbor works, and in such event the property so transferred shall be valued and credited to the project upon which it was theretofore used and charged to the project to which it shall be transferred. The Secretary may also direct a temporary transfer of any property employed in the improvement of rivers and harbors whenever, in his judgment, such transfer would secure efficient or economical results, and such adjustment in the way of charges and credits shall be made between the projects affected as may be equitable.

* * * * *

SEC. 9. That section six of the river and harbor act of August eleventh, eighteen hundred and eighty-eight, is hereby amended so as to read as follows: "That for the purpose of securing the uninterrupted gauging of the waters of the Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition, from time to time, upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of nine thousand six hundred dollars: *Provided, however,* That an itemized statement of said expenses shall accompany the annual report of the Chief of Engineers."

* * * * *

SEC. 11. That section four of the river and harbor Act of August eighteenth, eighteen hundred and ninety-four, be, and is hereby, amended so as to read as follows:

"SEC. 4. That it shall be the duty of the Secretary of War to prescribe such rules and regulations for the use, administration, and navigation of any or all canals and similar works of navigation that now are, or that hereafter may be, owned, operated, or maintained by the United States as in his judgment the public necessity may require; and he is also authorized to prescribe regulations to govern the speed and movement of vessels and other water craft in any public navigable channel which has been improved under authority of Congress, whenever, in his judgment, such regulations are necessary to protect such improved channels from injury, or to prevent interference with the operations of the United States in improving navigable waters or injury to any plant that may be employed in such operations. Such rules and regulations shall be posted, in conspicuous and appropriate places, for the information of the public; and every person and every corporation which shall violate such rules and regulations shall be deemed guilty of a misdemeanor and, on conviction thereof in any district court of the United States within whose territorial jurisdiction such offense may have been committed, shall be punished by a fine not exceeding five hundred dollars, or by imprisonment (in the case of a natural person) not exceeding six months, in the discretion of the court."

* * * * *

SEC. 14. That the Secretary of War is hereby directed to cause preliminary examinations or surveys to be made at the localities named in this section as hereinafter provided. In all cases, unless a survey or estimate is herein expressly directed, a preliminary examination shall first be made, which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. Whenever such preliminary examination has been made, in case such improvement is not deemed advisable, no survey thereof or estimate therefor shall be made without the direction of Congress; but in case the report shall be to the effect that such river or harbor is

worthy of improvement, the Secretary of War is hereby directed, at his discretion, to cause surveys to be made and the cost of improving such river or harbor to be estimated and to be reported to Congress: *Provided*, That in all cases preliminary examinations, as well as surveys, provided for in this Act shall be examined and reviewed by the board provided for in section three of this Act, to wit:

* * * * * *

Mississippi River in front of Wickliffe, Kentucky, with a view to ascertaining what improvement is necessary to preserve the harbor and facilitate navigation; such examination to be made by the Mississippi River Commission.

* * * * * *

Approved, June 13, 1902.

APPENDIX 1 B.

REPORT OF ASSISTANT ENGINEER KIVAS TULLY ON GAUGES, DISCHARGE OBSERVATIONS, REDUCTION OF PHYSICAL DATA, AND OFFICE PUBLICATIONS.

St. Louis, Mo., May 31, 1902.

CAPTAIN: I have the honor to submit the following report upon the work pertaining to gauges, discharge observations, and office publications since May 31, 1901:

GAUGES.

The water gauges maintained by the Commission comprise three kinds, designated for convenience, respectively, permanent gauges, high-water gauges, and tide gauges.

The most important of these are the regular or permanent gauges. These are distributed on the main river at and below St. Louis, and on the principal tributaries. Readings are taken on these gauges twice daily throughout the year by observers permanently employed, who also display the gauge readings on large figured plates in bulletin frames on the river bank for the information of pilots on passing boats. Many of these gauges are also used by observers of the United States Weather Bureau, who telegraph the readings to their central stations for daily publication. These gauges are of different types, and generally as stable as the nature of the banks will admit of.

The high-water gauges are intended to supplement the permanent or regular gauges. There are 182 of these high-water gauges, placed about 5 miles apart on the main river from Cairo to Fort Jackson. They are read only at times of more than ordinary high water, and by special temporary observers.

The tide gauges are self-registering and are cared for by permanent observers. One is at Biloxi, Miss., and one at East Bay, La.

The following is a detailed description of the above-mentioned gauges under their respective heads:

PERMANENT GAUGES.

The regular permanent gauges on the Mississippi River and its tributaries now under control of the Mississippi River Commission number 38. Of these, 17 were established by the Commission and 21 were received by transfer from the United States Engineer office at Vicksburg, Miss., on February 11, 1901. These latter gauges, which are generally referred to as the United States Engineer or Merrill gauges, were mainly established by Major Merrill in 1871-72.

In addition to the above gauges, a staff gauge was established April 20, 1902, at Aitkin, Minn., 1,086 miles above Cairo, for use in connection with the survey of the river above St. Paul, Minn.

The gauges established by the Commission are maintained under allotments made by the Commission from appropriations for continuing improvement of Mississippi River from Head of the Passes to the mouth of the Ohio River.

The Merrill or United States Engineer gauges are maintained under allotments made from permanent appropriation under section 6 of the river and harbor act of August 11, 1888. A list of these gauges will be found on page 126, Supplement to the Report of Chief of Engineers for 1901.

The 38 permanent gauges are distributed as follows: Twenty-five on the Mississippi River; 1 each on the Arkansas, Atchafalaya, Cumberland, Tennessee, and St. Francis rivers; 3 each on the Ohio and Red rivers, and 2 on the White River.

The elevations of gauge zeros on the main river at and below Red River Landing, and on the Atchafalaya, Red, and Ouachita rivers, are referred to the adopted mean Gulf level at Biloxi, Miss. The other gauges will be referred to Gulf level when the releveling by the Commission is sufficiently extended up the river; in the meantime the old reference to the Cairo datum plane is given in the Table No. 2. In advance of the releveling the Cairo datum may be taken as approximately 20.2 feet below the adopted mean Gulf level.

A general inspection was made of these gauges during the low-water season of 1901 and the gauges and bulletins put in good order. One party in charge of Junior Engineer George H. Wolbrecht on the U. S. S. *Patrol* inspected and repaired all the gauges on the main river from Cairo to Carrollton. The consolidation of all the gauges under one control facilitated this arrangement and will, no doubt, result in more efficient inspection service. The bulletin frames and plates at the gauge stations were repaired and painted. The bulletins used by the Commission are shown in a plate opposite page 3655, Report of Chief of Engineers for 1893. The form of bulletin used at the Engineer gauges is shown on plate opposite page 2058 of same report. A view of a vertical staff gauge is also given on the same plate.

During the last low-water inspection trip special attention was directed to making the descriptions of the gauges and their bench marks complete and accurate and to verification of the elevations of the gauge bench marks. As the permanent gauges on the main river can now be given here practically for the first time in their proper geographical order, it is thought desirable to make the description of each gauge in the following list sufficiently full for future identification and to give its elevation with reference to at least one bench mark of a permanent character. When the bench mark has been fully described in some previously published report its designation only will be given here. The distances from Cairo of the different gauges will be found in Table No. 2, together with elevations of the gauge zeros and highest and lowest readings on each gauge.

LIST AND DESCRIPTION OF PERMANENT GAUGES.

[The United States Engineer or Merrill gauge stations are distinguished in the following descriptions by an asterisk.]

MISSISSIPPI RIVER.

**St. Louis, Mo.*—This gauge from zero up to 31.3 feet is made of railroad iron spiked to a heavy wooden stringer. Its length up the paved levee or wharf is about 198 feet. The top of rail is flush with the surface of the paving stones. It was built in 1873 and regruated in 1894. The woodwork is much decayed, and the whole gauge needs reconstruction. This gauge is opposite No. 4 south wharf, just south of Market street.

The gauge is extended by vertical sections. One of these is on the south side of the harbor office and reads from 30 to 36 feet; another is painted on steel pillar of the Merchants' Terminal Railway at foot of Market street. The readings below zero are taken on temporary vertical stakes. The river bulletin is on steel girders of the same elevated railway, near the gauge.

The gauge was inspected on December 20 and 23, 1901. The gauge bench marks were connected by precise levels in January, 1902. P. B. M. 15 is 36.43 feet above the zero of the gauge.

Cape Girardeau, Mo.—This gauge is at lower end of city wharf at foot of Independence street, and is in vertical sections. Some of the sections had been disturbed by railroad men before the high water of 1901. On June 19, 1901, the gauge was rebuilt correctly, and was found correct at inspection of January 9, 1902. The high-water reading for 1901 has been deduced from the Grays Point gauge. P. B. M. 54 is 41.67 feet above the zero of gauge.

**Cairo, Ill. (on the Ohio River).*—This gauge consists of a portion of the old inclined gauge, and seven vertical sections. The inclined section is on the levee at foot of Fourth street, and reads from 1 to 38 feet. Sections 29 to 53 feet are fastened to a pile standing 15 meters below the inclined section. Some extra sections are attached to the Halliday warehouse. This gauge was inspected October 15, 1901. No errors greater than 0.07 foot were found in the gauge. The inclined gauge should be rebuilt, the timbers above 38 feet having rotted away and below that showing signs of decay. The bulletin is at top of paved levee and a short distance upstream from the gauge. P. B. M. 1, hole in copper bolt set in northwest side of custom-house, is 47.09 feet above zero of the gauge.

Belmont, Mo.—This gauge was partly destroyed in March, 1902, by the burning of the grain elevator to which it was attached. On April 10, 1902, the upper sections

of the gauge reading from 32 to 51 feet were rebuilt. The lower sections were under water at the time of fire and were not affected. The bulletin was destroyed by the fire and a smaller bulletin has been temporarily placed in position just below the ruins of the elevator. Since the river pilots have expressed a desire to have the bulletin located at Columbus, Ky., nearly directly across the river from Belmont, it would seem desirable that the gauge be also moved across to Columbus, which was the original site of the gauge; it was moved to Belmont in 1884. Stone line B. M. $\frac{3}{4}$ is 43.33 feet above the zero of the gauge.

New Madrid, Mo.—This gauge is situated on the right bank of the Mississippi River, about one-half mile above the town of New Madrid. The gauge reads from zero to 41 feet and consists of one inclined and six vertical sections. The gauge was practically correct at inspection October 21, 1901. The bulletin is on top of bank at upper end of town.

Cottonwood Point, Mo.—This gauge is situated about three-fourths of a mile above the Cottonwood Point post-office. The high-water section and inclined gauge are near the mouth of chute of Island 18; the low-water sections are on the sand bar about 450 meters below mouth of the chute. All the sections of the gauge above 10 feet were practically correct at inspection of October 24; the temporary sections below 10 feet were found in error 0.18 foot. The gauge was rebuilt in part and left correct throughout, reading from zero to 43 feet. Triangulation station north base is 34.17 feet above zero of the gauge. The bulletin is on top of bank just back of the low-water sections of gauge.

Fulton, Tenn.—The gauge is situated at the downstream side of a prominent gully about 120 meters above the landing at Fulton. The sections below 22 feet were temporary, and at inspection October 29–30 were found to be from 0.2 to 0.3 foot too low; the upper sections were found correct. An inclined gauge reading from 6.8 to 24.3 feet was built on the sloping bank, and vertical sections to make the gauge complete from 1 to 40 feet were rebuilt. B. M. 1, 1892, is a tile and iron pipe set inland from gauge about 75 feet. It is about 90 meters above Fulton Landing, near foot of bluff on upstream side of gully. Elevation above zero of gauge: Cap on pipe, 37.87 feet; tile, 33.89 feet. Bulletin is on top of bank at Fulton Landing.

Memphis, Tenn.—The gauge is below the foot of Beale street at the inclined railway of the Pittsburg Coal Company. At inspection, November 4, the various sections were found to be practically correct, except one section, 4 to 9 feet, which was 0.12 foot too high. One inclined section from 3.5 to 21.5 feet was built, and 5 vertical sections were rebuilt at the railway incline at last inspection, November 4. The gauge complete reads from –2 to 41 feet. P. B. M. Memphis is 80.41 feet above zero of the gauge. The gauge bulletin is in custom-house inclosure, about one-half mile upstream from the gauge. A new inclined gauge should be constructed in the paved levee at this station.

Mhoon Landing, Miss.—This gauge is in vertical sections near Mhoon Landing. The low-water section is about 100 meters below the landing; the highest section is about 150 meters above the landing; other sections are from 300 to 450 meters above the landing. The whole gauge reads from –7 to 45 feet. The sections from –7 to 30 feet were rebuilt at the inspection of November 7. The unstable nature of the banks at this station necessitates frequent changes in the position of the gauge sections. A new gauge observer was appointed at this station on December 9, 1901, since which time the records are apparently good. Prior to that date for some time the records were not satisfactory. Stone line B. M. $\frac{1}{2}$ is 33.69 feet above the zero of the gauge.

Helena, Ark.—This gauge is situated in front of the town and is in vertical sections. The section of gauge in use at inspection of November 11 was 0.08 foot too low; the high-water section was correct. The gauge was rebuilt from 1 to 44 feet; the whole gauge reads from 1 to 53 feet. P. B. M. Helena II is 50.12 feet above zero of gauge. The bulletin is on low roof of building on north side of street, about one-fourth mile down stream from gauge site.

Sunflower Landing, Miss.—This gauge is situated at mouth of Hushpucana Creek, just above Sunflower Landing. There are two inclined sections, built at last inspection, November 14, 1901; these read from 11.5 to 38.5 feet. The low-water sections were found at inspection to be 0.08 foot too high and were rebuilt. The whole gauge reads from 1 to 49 feet. Stone line B. M. $\frac{3}{4}$ is 43.81 feet above the zero of gauge. The bulletin is on top of bank at the landing and about 200 meters below the gauge site.

Mouth of White River, Arkansas.—This gauge is situated on the right bank of the Mississippi River, about three-fourths mile below the mouth of White River. The gauge reads from 3 to 53 feet in vertical sections, nailed to trees and posts. The low-water section was found to be 0.11 foot too low at last inspection, due to settling of

the soft ground. The gauge was rebuilt from 3 to 46 feet. The bulletin is at Cumbyville Landing, about 400 meters below the gauge site. B. M. A. (Ewens, 1896) is stone and pipe in southeast corner of Louis Bush's front yard. Elevations above zero of gauge: Copper bolt in stone, 41.39 feet; top of cap on pipe, 45.46 feet.

Arkansas City, Ark.—This gauge is situated in front of the town and is in vertical sections; the sections above 19 feet are in front of the railroad station; the low-water section is about 200 meters above the station and the section reading from 6 to 19 feet is about 200 meters below the station. The section from 6 to 11 feet was missing at last inspection, November 21, 1901; the other sections were found to be correct. New sections were put up from -1 to 50 feet, as the figures on old sections had become dim. P. B. M. F. (C. & G. S.), bottom of square cavity in 6 by 6 inch stone post, is 42.43 feet above the zero of the gauge. The bulletin is at top of levee and about 175 meters below the railroad station.

Greenville, Miss.—The high and low water sections of this gauge are vertical and are situated near the foot of Main street. The inclined section reads from 8 to 43.5 feet and is situated on the railway incline of the Greenville Wharf and Storage Company, about 92 meters below Central avenue. A temporary low-water section, found in use at inspection of November 23, 1901, was 0'.06 too high. The other sections were practically correct, but as the wood was decayed a new inclined section was put in place on the return trip, December 30, 1901. The entire gauge reads from -1.5 to 50 feet. The bulletin is on the levee near foot of Main street. P. B. M. 1 (C. & G. S.) is 43.2 feet above zero of the gauge.

**Lake Providence, La.*—This gauge consists of three vertical sections and one inclined section. The inclined section reads from 1.8 to 34.7 feet and is situated on sloping bank below the revetment work and 76 meters above Lake Providence upper landing. The low-water section is just in front of the inclined gauge. The high-water sections are at the lower landing. The entire gauge reads from -3.5 to 52 feet. The temporary low-water section was found to be 0.15 foot too low at inspection of November 27-28, 1901. The gauge was partly rebuilt at the November inspection, and the rebuilding was completed on the return trip, December 27-30. Triangulation station South Base, which is also stone line B. M. 4³, is 32.62 feet above the zero of the gauge. The bulletin is just above Lake Providence lower landing.

**Vicksburg (Kleinston), Miss.*—This gauge is in vertical sections on the guard piling of the Alabama and Vicksburg Railroad transfer incline at Kleinston, about 1½ miles below Vicksburg. The gauge reads from -6 to 54 feet. The sections below 20 feet were found to be 0.11 to 0.15 foot too high. The gauge was rebuilt from zero to 42 feet at inspection on November 30, 1901. Stone line B. M. 14⁷ is 42.31 feet above the zero of the gauge. The bulletin is just below the incline.

St. Joseph, La.—The gauge is situated about three-fourths of a mile below the town of St. Joseph. The gauge is in vertical sections. Before the inspection of December 3, 1901, all the sections below 27 feet had caved into the river; the temporary gauge in use was found to be 0.33 foot too high. The gauge was rebuilt from -7 to 40 feet; the entire gauge reads up to 51 feet. P. B. M. 291 (C. & G. S.) is 43.68 feet above the zero of the gauge. The bulletin is on top of bank just below the warehouse at St. Joseph lower landing.

**Natchez, Miss.*—This gauge is situated "under the hill" at Natchez, and is in vertical sections, reading from 1 to 53 feet. The sections above 10 feet are on piling of the incline of the Bluff City Railway Company's elevator. The low-water section is about 46 meters above upper end of the elevator. At inspection of December 5, 1901, the low-water section in use was found to be 0.6 foot too low. The gauge had been disturbed, probably by gradual settling of the banks. The records were corrected by means of a coordinate plot with St. Joseph gauge readings. The gauge was rebuilt at the inspections of December 5 and 23, 1901, from 1 to 52 feet. P. B. M. 1 is flat stone and iron pipe on the bluff. The copper bolt in stone is 178.56 feet above zero of gauge. The knob on cap of pipe is 1.24 meters above the bolt. The bulletin is near the office building of the Pittsburg Coal Company.

**Red River Landing, La.*—This gauge is in vertical sections. The high-water section, 42 to 52 feet, is at the landing a little below Reagan's store. The other sections are about 95 meters above the landing. The sections below 42 feet had been destroyed before the inspection of December 7-8, 1901, and the temporary low-water section was found to be 0.7 foot too high. The gauge was rebuilt up to 43 feet and now reads from 1 to 52 feet. Stone line B. M. 14⁹, top of stone post on inner slope of levee, is 48.74 feet above the zero of the gauge. The bulletin is on the river bank below the landing.

Bayou Sara, La.—This gauge is situated in front of the town. The sections reading up to 30 feet are near the foot of Del Oxiente street. The high-water section is about 245 meters downstream from that street. The whole gauge reads from -2 to 44 feet

in vertical sections. Owing to settling of the river banks at this locality, much difficulty in maintaining the gauge has been experienced in the past. At last inspection, December 9, 1901, the temporary low-water section in use was in error less than 0.1 foot, but several other sections below 20 feet were in error by varying amounts, ranging as high as 0.88 foot, due to settling of banks and disturbance by boats. The upper sections were found to be practically correct. The gauge from -2 to 20 feet was rebuilt on heavy posts in vertical sections on December 9, 1901. B. M. 1 (Herman, 1898) is tile and iron pipe, just outside of fence on east side of Del Oxiante street and 3 feet south of south line of Commerce street. No bolt in tile. Elevations above zero of gauge: Cap on pipe, 35.21 feet; tile, 31.22 feet.

**Baton Rouge, La.*—This gauge is situated in front of the town and is in vertical sections. The high and low water sections are at foot of Convention street. The intermediate sections are about midway between that street and North boulevard. At inspection of December 10, 1901, the low-water section in use was found to be correct. The upper sections were found to have settled with the new levee on which they had been built. They had not been in use, however, after the settlement occurred. The gauge was rebuilt at inspections of December 9 and 19, 1901, from 7 to 41.5 feet. The bulletin is on office building of the coal and coke company, corner of Convention and Front streets. B. M. 2 is top of inner cap (at southwest corner) that covers the pediment on which rests the seventh post on west side from the northwest corner of fence surrounding the statehouse. It is marked U. S. E. under the figures 75. Elevation above zero of gauge, 34.77 feet. It is necessary to remove some loose earth to get at this bench.

Plaquemine, La.—This gauge is situated in front of the town, between Seminary and Marion streets. It consists of one inclined section and several vertical sections, and reads from -1 to 39 feet. The section from 27 to 40 feet was missing at inspection of December 10, 1901; the other sections were correct. The gauge was rebuilt at inspection from 8 to 15 and 27 to 39 feet. Bulletin is on top of levee near foot of Seminary street. B. M. A (Ewens, 1883) is the outer and downstream corner of iron doorsill of south doorway of Roth & McWilliams's store. Marked "A" with tacks in woodwork. It is 27.32 feet above the zero of the gauge.

**Donaldsonville, La.*—This gauge is situated outside the levee, at the foot of Houmas street. It is in vertical sections and reads from 1 to 35 feet. The low-water section found in use at inspection December 11, 1901, was 0.11 foot too low. Some smaller errors were also found in other sections. The gauge was rebuilt from 1 to 22 feet. B. M. B is top of the letter B in the name N. Bel., on the iron doorplate of the Chetamatchez street doorway of building occupied by the Mohawk Club, at the northwest corner of Chetamatchez and Mississippi streets. Elevation above zero of the gauge is 27.48 feet. The observer, in accordance with instructions, is now recording the exact readings of the gauge, but states that in previous years he had been applying a correction to eliminate tidal effect.

College Point, La.—The lower vertical sections of this gauge are situated at the College Point ferry landing. The inclined gauge and upper vertical sections are about 125 meters below College Point landing, and nearly due west from Jefferson College. At inspection, December 12, 1901, the gauge sections were found practically correct. The gauge was rebuilt from 10 to 22.5 feet. P. B. M. XIII is 25.54 feet above the zero of the gauge.

**Carrollton, La.*—The gauge is situated near the foot of St. Charles avenue, now in the city of New Orleans, La. The gauge is in one inclined section and several vertical sections. The section in use at last inspection, December 14, 1901, was found to be 0.18 foot too low. The gauge was rebuilt from -1 to 20 feet. The bulletin is on top of outer levee at foot of St. Charles avenue. City B. M. XX stone is 4.75 feet above zero of gauge.

Fort Jackson, La.—This is a vertical staff gauge situated on the right bank of the Mississippi River in a cove about 300 meters above Fort Jackson. It reads from 0 to 10 feet. At last inspection, October 4, 1901, the 8-foot mark was found to be 0.02 foot too low by connection with spike B. M. in tree at 8 feet above zero of gauge. The zero of Fort Jackson gauge is 1.677 feet below mean Gulf level at Biloxi, Miss., by direct precise level connection. P. B. M. 10 is 3.785 feet above the same datum, and is, therefore, 5.462 feet above zero of the gauge. No bulletin is maintained at this station.

ARKANSAS RIVER.

**Little Rock, Ark.*—This gauge is on the piers of the St. Louis, Iron Mountain and Southern Railway bridge, known as the Baring Cross Bridge. It is the upper one of four bridges at Little Rock. One section, 16.2 to 32 feet, is painted on the land face of downstream cylinder of first pier on Little Rock side. Another section, reading from -0.2 to 32.5 feet, is on framework of pivot pier. Both sections were found to be correct at last inspection of October 31, 1901, by connection with B. M. A (Ewens,

1889). B. M. 6 is bottom surface of iron cylinder cap of downstream cylinder of second abutment pier from right bank of Baring Cross Bridge; elevation above zero of gauge, 41.40 feet. The bulletin is on bluffs about 75 meters below the bridge. The earlier records at this station seem doubtful, owing to possible changes in the elevation of gauge. The earlier level notes are to be investigated, and if possible all readings will be referred to present gauge zero.

ATCHAFALAYA RIVER.

Barbre Landing, La.—This gauge is at Barbre Landing, about one-fourth mile above head of the Atchafalaya River. It is in charge of the Fourth district officer. At last inspection, December 8, 1901, the temporary section found in use was about 0.06 foot too low. P. B. M. 92 (Red River survey) is stone and pipe; elevation above zero of gauge, cap on pipe, 44.99 feet.

CUMBERLAND RIVER.

**Nashville, Tenn.*—This is on the levee at the foot of Broad street. The principal part of the gauge is an inclined section about 304 feet long reading from 0 to 46 feet. It was constructed in 1873, and consists of an iron strap, 4 by $\frac{3}{8}$ inch, spiked on a timber stringer laid in the ground; it terminates at Front street. At last inspection, October 10, 1901, this gauge was found in good condition. A high-water section attached to building on corner of Front and Broad streets was leveled to at about the 53.5-foot mark and found to agree with inclined section. B. M. 1 (Merrell) is cross cut on upper face of corner stone at southeast corner of Temperance Hall on Broad street near Front street. Elevation above zero of the gauge, 51.98 feet.

OHIO RIVER.

**Louisville, Ky.*—There are two gauges, known as the upper and lower gauges, located respectively at the head and foot of the Louisville and Portland Canal. Zero of upper gauge reads 35 feet and zero of lower gauge reads 8.09 feet on canal levels. The gauges are vertical; the upper is cut on north pier of guard lock gates at entrance to locks, being about 150 feet above first lock pit or upper gates. The lower gauge is in five sections; the lower portion is cut on the tail wall of the double lock, at foot of canal; the upper portion is cut in the canal wall above the double lock and below the guard gate and lower bridge. The canal datum plane is 6.09 feet below top of lower miter sill.

RED RIVER.

**Fulton, Ark.*—The gauge is in vertical sections, just above the St. Louis, Iron Mountain and Southern Railway bridge at Fulton. Sections reading from 16 to 35 feet are on the left bank about 40 meters above the bridge. Sections reading below 15.5 feet are on the right bank immediately above the bridge. At the last inspection, October 30, 1901, some errors of less than one-tenth foot were found in the different sections and the gauge was rebuilt 3.5 to 15.5 feet. The bulletin is on top of bank on the Fulton side, just above the bridge. B. M. 2 (Red River survey), elevations above zero of gauge: Cap on pipe, 34.95; copper bolt in stone, 30.89 feet.

**Shreveport, La.*—The upper sections of this gauge are on the piers of the Vicksburg, Shreveport and Pacific Railroad bridge (used also as a highway bridge) at the foot of Cotton street. The lowest section, reading from -8 to 0 feet, is on piling above the bridge. B. M. 2 is cross cut in lower cap of retaining wall on southwest side of Vicksburg, Shreveport and Pacific Railroad bridge in Shreveport. Elevation above zero of gauge, 40.81 feet. Bulletin is just outside of railroad tracks and about 60 meters above bridge.

**Alexandria, La.*—The gauge is in vertical sections along the river bank between the ferry landing and the foot of Washington street. Some sections were missing at last inspection, October 26, 1901. The gauge was partly rebuilt and made complete from -2 to 39 feet. The bulletin is on porch of store building just above the gauge. B. M. 4 (Miller, 1883) is top surface of the east corner of the lower iron plate of the iron pedestal of the southeast pillar of vestibule of the Alexandria court-house, river entrance. Elevation above zero of gauge, 37.945 feet. Arrangements have been made to have new sections attached to pier of new highway bridge which is being constructed near the present gauge site.

ST. FRANCIS RIVER.

Bridge of St. Louis, Iron Mountain and Southern Railway (Memphis branch).—This gauge, above 6 feet, is on framework between cylinder piers of the railway bridge across the St. Francis River, about 14 miles by river above Wittsburg, Ark. The low-water

section is on center pier of drawspan. It was moved here from Wittsburg, Ark., in 1892. Base of rail on bridge is 53 feet above zero of gauge. There is no bulletin at this station and none is required.

TENNESSEE RIVER.

**Florence, Ala.*—The old gauge at this place was a wooden upright attached to crib of pivot pier of Southern Railway bridge. This crib has been settling away from the pier for some years, and gauge was reset frequently. On February 14, 1902, a new gauge was put up, consisting of steel sections $\frac{3}{4}$ by $7\frac{1}{4}$ inches attached to face of stone draw pier of same bridge by bolts leaded into stone. The new gauge reads from -1.92 to 33.5 feet. B. M. 1 (Merrill, 1871) is southeast corner of the top of the first small pier north of the bridge. P. B. M. 12 at Florence is 31.22 feet above zero of gauge.

WHITE RIVER.

**Jacksonport, Ark.*—The gauge is in vertical sections, situated near the foot of the principal street of Jacksonport. Section reading from 26.5 to 38 feet is attached to corner of old railroad station about 70 meters below the above-mentioned street. At inspection of November 1, 1901, small errors were found in the various sections. The gauge was rebuilt from 26.5 to 38 feet and below 9 feet. B. M. 4 (Dukes, 1874) is copper plug in southwest corner of the old court-house, now used as cotton gin; elevation above zero of the gauge, 30.30 feet. Bulletin is on top of bank, near the old railroad station.

Clarendon, Ark.—This gauge is attached to cross bracing between two cylinders of pier at east end of drawspan of Cotton Belt Railway. Gauge reads from 4 to 38 feet. Gauge was found practically correct at last inspection, November 2, 1901. B. M. stone post 2 U. S. is 6 by 6 inch granite post with the letters "U. S." cut in upper surface. It stands near east side of street, about due west of center of court-house and 11 feet west of west fence of court-house yard. Elevation above zero of gauge, 33.49 feet. Bulletin is on top of bank, about 25 meters below the bridge.

The gauge inspections were mainly made about the time of extreme low water of the year, thereby insuring a reliable determination of the low water at the various stations. The extreme high-water sections of the gauges are not liable to disturbance to the extent that the low-water sections are, and it is thought these are also very reliable this year. Corrections for any errors found by leveling have been applied to both high and low readings, these errors being generally quite small. The highest and lowest readings at each gauge station during 1901 are given in Table No. 2. The highest for 1902, to May 31, are given in Table No. 3. The zero elevations are the same as last year. It is hoped that the leveling will be extended upstream at an early date, so that all the gauge zeros may be reliably referred to the adopted mean Gulf level. A hydrograph showing the daily stages of the main river from Cairo, Ill., to Fort Jackson, La., from June 1, 1901, to May 31, 1902, is given on plate 1.

The office hydrographs, on which are plotted the daily readings of all the gauges, are kept carefully plotted up as fast as the records are received, in order to reveal any discrepancies in the reported readings. When such discrepancies occur they are adjusted, if possible, at the time or at next inspection. These hydrographs, in three sheets, are traced and blue-printed for distribution at the end of the year.

The daily readings of the gauges are also blue-printed and distributed to the Commissioners and district officers each month.

HIGH-WATER GAUGES.

These gauges were established in 1896 for the purpose of determining the high-water profile of the Mississippi River below Cairo in connection with the regular gauges. These gauges are in one section, mainly nailed to trees, about 5 miles apart, between Cairo and Fort Jackson, La. The graduations are to feet and tenths above the Memphis datum plane, and cover a range of from about 7 to 12 feet. Readings are to be taken on these gauges in future only when the river reaches an unusually high stage, as prescribed for discharge observations. These gauges were inspected and repaired by the party on the steamer *Patrol* during October to December, 1901. Slight changes have been made in the locations of these gauges from year to year to accommodate them to local conditions. The maximum readings on these gauges during the high water of 1901 are given in Table No. 4. The profile is shown on plate No. 2. The high water of 1897 is also given for comparison. The high water of 1902 did not reach the prescribed limit and is not given. This high water was lower than that of 1901 at Cairo, but exceeded it on the lower part of the river, as will be seen from a comparison of the regular gauge readings in Tables Nos. 2 and 3.

LOW-WATER SLOPE.

The party on the *Patrol* leveled to the water surface near the high-water gauges during the down trip of inspection from Cairo to Red River Landing, October 14 to December 7, 1901. The elevations so determined, corrected to agree with the lowest stage observed at each regular gauge station, are given in Table No. 5. This correction at Cairo was -4.34 feet, at Memphis -1.20 feet, at Helena -0.89 foot, and below mouth of White River less than one-half foot. The profile is given on plate No. 2.

TIDE GAUGES.

The automatic record of the tidal oscillation at Biloxi, Miss., and East Bay, La., is not available from July 26 to October 22, 1901, by reason of a severe storm which visited the Gulf coast about August 13. This storm swept away the gauge house at Biloxi, and the automatic gauge and portion of tide roll were lost. The gauge house at East Bay was damaged, but its contents were saved. Steps were immediately taken to reestablish both stations, and a new and improved tide gauge was ordered from Hugo Bilgram, of Philadelphia. An attachment was devised for the new gauge, operated by a separate clock, by means of which the time is recorded on the tide roll every hour automatically. Two views of this gauge are given on plate 3. The arms A A are tripped by the lever B every hour. The hammers at the ends of the arms are provided with needle points, which penetrate through the paper into grooves cut in the brass cylinder at c c. The pencil D, which records the tide level, is in line with these two points, which locate the hourly ordinate for scaling. This gauge is otherwise the same as the latest Coast Survey model of the Stierle tide gauge.

The staff gauges at both stations were apparently undisturbed by the storm, but new gauges were placed near the old ones. The micrometer attachment used on the staff gauge at Biloxi was damaged. This was repaired and a new one made for the gauge at East Bay. The new micrometer is similar to that shown on plate 16, following page 3758, Report of the Chief of Engineers for 1896, except that a guide rod was attached to the lower side of float and extended down into the inlet pipe B. This makes the float work very smoothly. Both gauge houses were rebuilt, and when the new gauge was received from the maker in October records were resumed at both stations and have been continuous since. A map showing the respective locations of these gauges is given on plate 11, following page 3502, Report of the Chief of Engineers for 1899. The records are now being reduced, and when the series is further extended will be discussed in a future report.

DISCHARGE OBSERVATIONS.

The discharge observations during the past year consisted of measuring the low-water discharge of the Mississippi River at Columbus, Ky., Helena, Ark., and Arkansas City, Ark., in November, 1901, and measuring the high-water discharge of the Cumberland River in April, 1902.

The low-water discharge observations were made by a party on the small steamer *Mercury*, in charge of Mr. W. G. Comber, assistant engineer, at about the lowest stage of the season. The Haskell meter with wheel No. 6 was used. Measurements were also made with double floats. The observations were made in the usual manner, with the meter at six-tenths depth and the subsurface float at five-tenths depth. The meter was generally run for five minutes at each velocity station. The floats were run over a distance between ranges of 400 feet. The soundings were taken with 10 and 12 pound leads and three-eighths-inch cotton line. A sounding line was first used at Columbus, borrowed from a ferry boat until the arrival of the regular lead line. This first line showed great variation in length on different days when tested, and as apparently this was caused by the line responding easily to the different tensions when testing the mean of all the tests was taken for the correction to the soundings in the final reduction. The regular line used later was seasoned and showed comparatively small variations under tests. It is the intention to hereafter use a spring balance in testing sounding lines to insure a uniform tension.

The results of these discharge observations, as finally reduced, are fairly accordant except at Helena, where for some as yet undiscovered reason the meter generally gave much smaller discharges than did the double floats. As compared also with observations of other years at this station the meter results are small.

The meter wheel, Haskell No. 6, was rated twice during the season. The results of the two sets were combined, giving to the constants weight inversely as the squares of their mean errors in each set. The following are the equations, in which y =velocity in feet per second and x =number of revolutions per second:

$$y = 1.12168 x + 0.2361 \text{ chute near Cherokee, November 28, 1901.}$$

$$y = 1.2458 x + 0.0959 \text{ near Centennial Lake, December 16, 1901.}$$

$$y = 1.15783 x + 0.2122 \text{ weighted means.}$$

Ratings made at Bissells Point, St. Louis, May, 1902, indicate that this wheel is not in first-class condition.

The results of final reduction of the low-water discharges are given in Table No. 6.

At the conclusion of the low-water discharge measurements the party laid out discharge ranges at Warrenton, Miss., on the main river, and near Haynes Bluff, Mississippi, on the Yazoo River.

In January, 1902, a party on the steamer *Patrol*, under the personal direction of the secretary, made a reconnaissance of the lower portions of the Tennessee and Cumberland rivers and established discharge ranges for future use; that on the Tennessee is about 26 miles above its mouth, and on the Cumberland 53 miles above its mouth. Discharge ranges were also established by Mr. E. L. Harman, junior engineer, on the Arkansas River at Little Rock, and on the St. Francis River about 125 miles above its mouth.

As the Cumberland River, early in April of this year, reached the stage prescribed by the Commission for measuring the discharge, the steamer *Patrol* was sent up from Memphis, and a small party in charge of Mr. C. M. Talbert, junior engineer, occupied the station established in January at Empire Landing, near Rock Castle, Ky., about 53 miles above the mouth. The river discharge was measured nine times on April 5 to 8, and the overbank discharge three times. The overbank discharge was taken along a road which was about normal to the flow and 1,100 meters above the river-discharge section. Six of the river discharges were taken with the Haskell meter wheel No. †, and three with double floats. The results as finally reduced seem fairly accordant. The first two float discharges are probably slightly too small, as a larger stick and flag than usual were used on the surface float; and as at the time there was an upstream wind, the velocity was no doubt retarded. A smaller stick and flag were used in the last set of float observations.

The soundings were taken with a three-eighths-inch line and 16-pound lead. A 22-pound lead was used on April 7.

The meter wheel No. † was rated at the close of the discharge work on April 9, in a pond or lake near Kutawa, Ky., all but three of the runs being made in the same direction. Apparently there was a slight current in the lake, and this rating had, therefore, to be rejected. Two sets of ratings of this wheel No. † were made at Bissells Point, St. Louis, on May 19 and 21, 1902. The meter constants derived from these two sets have been used in computing the Cumberland River discharges. The values in the two sets have been weighted in the same manner as described for wheel No. 6, and are as follows:

$$y = 1.84926 x + 0.11583. \quad \text{May 19, 1902.}$$

$$y = 1.87285 x + 0.11640. \quad \text{May 21, 1902.}$$

$$y = 1.85124 x + 0.1161.$$

The results of the final reduction of the discharges are given in Table No. 7.

The crest of the rise passed Rock Castle on April 8, four days after passing Nashville, Tenn.; its progress was probably retarded by overbank flow.

A staff gauge was put up at the discharge section, and will later be connected with the survey bench-marks.

The Haskell meter outfits have been overhauled, and additional meter wheels, registers, batteries, and stop watches obtained sufficient to equip two discharge parties.

A chronograph giving a continuous automatic record of the meter registrations would be a valuable addition to the meter outfit. This would also facilitate operating more than one meter on the same vertical.

All the meter wheels have recently been rated at the Bissells Point settling basins, and the observations are now being reduced. These observations have been made with great care, and, as far as the reduction has been carried, promise valuable results.

MISCELLANEOUS.

The Daily Stages of the Mississippi River and its Principal Tributaries, a pamphlet of 130 pages, was prepared and printed. The monthly reports of operations and proceedings of the eighty-third, eighty-fourth, and eighty-fifth sessions of the Commission have been printed. The scientific records and drawings of the secretary's office have been filed and cared for.

Messrs. E. J. Thomas, C. M. Talbert, junior engineers, and Mr. E. M. Hutchins, recorder, have rendered efficient and faithful service in this division during the year.

Respectfully submitted,

KIVAS TULLY,
Assistant Engineer.

Capt. G. P. HOWELL,
Corps of Engineers, U. S. Army, Secretary Mississippi River Commission.

TABLE NO. 1.—*Low-water slope, Mississippi River, Aitkin, Minn., to Minneapolis, Minn., 1901.*

Location.	Distance above Cairo.	Date of observation (1901).	Elevation above Memphis datum.	Fall between stations.	Distance between stations.	Slope per mile.
	Miles.		Feet.	Feet.	Miles.	Feet.
② Seeley	1,092	Nov. 15	1,200.9			
② Lower base	1,087	do	1,199.7	1.2	3.9	.287
Stone line 328	1,086	do	1,199.1	.6	2.7	.222
Stone line 327	1,083	Nov. 16	1,198.3	.8	3.0	.280
Stone line 326	1,076	do	1,197.0	1.3	6.8	.190
Stone line 325	1,072	do	1,196.0	1.0	4.0	.242
Stone line 324	1,069	do	1,194.5	1.5	3.4	.462
Stone line 323	1,065	do	1,192.6	1.9	3.5	.643
Stone line 322	1,061	Nov. 18	1,190.1	2.5	3.9	.638
Stone line 321	1,058	Nov. 19	1,188.4	1.7	3.6	.478
Stone line 320	1,054	do	1,186.1	2.3	3.8	.600
Stone line 319	1,050	do	1,183.4	2.7	3.4	.785
Stone line 318	1,048	Nov. 20	1,181.1	2.3	3.0	.757
Stone line 317	1,045	do	1,180.5	.6	2.8	.239
Stone line 316	1,042	do	1,180.4	.1	2.9	.038
Stone line 315	1,039	do	1,180.2	.2	2.9	.038
Stone line 314	1,036	Nov. 21	1,180.1	.1	3.4	.032
Above Brainerd dam	1,035	do	1,180.1	.0	.3	.000
Below Brainerd dam			1,162.5	17.6		
Stone line 313	1,033	Nov. 21	1,160.4	2.1	2.6	.808
Stone line 312	1,030	do	1,159.0	1.4	3.0	.480
Stone line 311	1,026	do	1,156.2	2.8	3.1	.903
Stone line 310	1,023	Nov. 22	1,154.2	2.0	3.2	.600
Stone line 309	1,020	do	1,152.3	1.9	3.2	.597
Stone line 308	1,017	do	1,150.2	2.1	3.1	.674
Stone line 307	1,014	do	1,147.1	3.1	2.8	1.136
Stone line 306	1,011	do	1,143.0	4.1	3.0	1.363
Stone line 305	1,008	Nov. 23	1,131.7	11.3	3.1	3.645
Stone line 304	1,005	do	1,121.4	10.3	3.1	3.323
Stone line 303	1,002	do	1,117.0	4.4	2.7	1.604
Stone line 302	999	do	1,111.8	5.2	2.9	1.793
Above Little Falls dam	997	do	1,111.7	.1	2.0	.050
Below Little Falls dam			1,093.1	18.6		
Stone line 301	996	Nov. 25	1,087.6	5.5	1.2	4.642
Stone line 300	993	do	1,079.2	8.4	2.9	2.879
Stone line 299	990	do	1,060.1	19.1	3.1	6.177
Stone line 298	987	do	1,042.7	17.4	3.0	5.797
Stone line 297	984	do	1,033.4	9.3	3.0	3.097
Stone line 296	981	Nov. 26	1,028.0	5.4	3.2	1.697
Stone line 295	978	do	1,022.7	5.3	3.0	1.747
Stone line 294	975	do	1,018.5	4.2	3.4	1.253
Stone line 293	972	do	1,014.3	4.2	2.6	1.615
Stone line 292	968	do	1,010.8	3.5	3.6	.964
Stone line 291	966	Nov. 27	1,007.7	3.1	2.0	1.555
Stone line 290	963	do	1,000.7	7.0	3.2	2.184
Stone line 289	960	do	985.6	15.1	3.1	4.871
Above St. Cloud dam	959	do	985.6	.0	1.0	.000
Below St. Cloud dam			971.3	14.3		
Stone line 288	957	Nov. 27	962.7	8.6	2.1	4.100
Stone line 287	954	do	953.7	9.0	3.1	2.900
Stone line 286	951	Nov. 29	946.2	7.5	3.3	2.258
Stone line 285	947	do	941.3	4.9	3.2	1.544
Stone line 284	945	Nov. 30	938.2	3.1	2.8	1.114
Stone line 283	941	do	936.0	2.2	3.7	.686
Stone line 282	938	do	928.5	7.5	2.7	2.789
Stone line 281	935	do	921.5	7.0	3.2	2.197
Stone line 280	932	do	910.7	10.8	2.8	3.850
Stone line 279	929	do	902.8	7.9	2.8	2.814
Stone line 278	926	Dec. 2	891.4	11.4	2.9	3.941
Stone line 277	924	do	879.1	12.3	2.9	4.224
Stone line 276	920	do	867.2	11.9	3.2	3.738
Stone line 275	918	do	859.4	7.8	2.9	2.683
Stone line 274	915	do	856.6	2.8	2.8	1.007
Stone line 273	912	do	845.2	11.4	3.2	3.562
Stone line 272	908	do	840.1	5.1	3.2	1.581
Stone line 271	905	Dec. 3	835.3	4.8	3.1	1.548
Stone line 270	902	do	826.7	8.6	3.1	2.774
Stone line 269	900	do	818.2	8.5	2.6	3.269
Stone line 268	896	do	812.7	5.5	3.9	1.415
Stone line 267	893	do	808.6	4.1	2.6	1.577
Stone line 266	890	do	805.2	3.4	3.2	1.066
Above St. Anthony Falls	887	do	801.8	3.4	2.8	1.218
Below St. Anthony Falls			756.6	45.2		
Above dam			756.6	0.0	.2	
Below dam			739.3	17.3		
Stone line 265	886	Dec. 4	728.6	10.8	.6	17.933

^aThe observed elevation of water surface at stone line 271 was 839.82 feet; at stone line 270 it was 832.66 feet; at stone line 269 it was 821.83 feet. This was abnormal on account of gorge below stone line 269, and the elevations were corrected by observer to read as given in this table.

TABLE No. 2.—*Highest and lowest gauge readings of 1901.—Continued.*

TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA—Continued.

River.	Station.	Approximate distance of stations from—	Highest.				Lowest.			
			Prior to 1901.		Difference compared with previous highest.	1901.		Difference compared with previous lowest.	1901.	
			Date.	Gauge reading.		Date.	Gauge reading.		Date.	Gauge reading.
Red	Fulton, Ark.	Miles..508	July 17, 1876	35.76	Fed. — 8.20	Oct. 20-22, 1886	Fed. — .10	Fed. 3.15	Nov. 2	Fed. — 1.00
Do. a.	Gariand, Ark.	Mouth..450	Mar. 24, 1894	28.50	— 19.70	Sept. 22-23, 1896	— 6.50	— 1.00	Nov. 6-9, 19-21	+ 4.50
Do.	Shreveport, La.	Mouth..320	May 28, 1892	35.70	16.40	Dec. 2-4, 1894	— 3.70	— 2.60	Dec. 1	+ 1.10
Do.	Alexandria, La.	Mouth..110	June 12-13, 1894	44.18	14.00	Sept. 23, 1891	— 3.70	— 2.60	Nov. 3-11	— .35
St. Francis	Bridge St. Louis, Iron Mountain and Southern Rwy.	Mouth..194	Apr. 4-6, 1897	41.60	14.50	Nov. 15-25, 1897	— 3.60	— .05		
Do. a.	Wittsburg, Ark.	Mouth..180	Apr. 28, 1886	42.02		Oct. 27-31, Nov. 10-14, 1892	— 3.60			
Tennessee	Chattanooga, Tenn.	Calro...485	Mar. 1, 1875	54.00	— 16.60	Sept. 11-14, 1881	.00	2.10	Nov. 22	+ 2.10
Do.	Florence, Ala.	Calro...300	Mar. 19, 1897	32.20	— 13.28	Oct. 1872, Sept. 18, 1878	— .76	.80	Nov. 22-25	+ 1.56
Wabash	Mount Carmel, Ill.	Calro...190	Aug. 7, 1875	28.80	— 10.80	Nov. 7-23, 1895	— .20	.00	Oct. 5-12	+ .20
White	Jacksonport, Ark.	Mouth..390	Mar. 14, 1890	33.35	— 8.85	Dec. 24, 1872	— 1.10	— .75	Oct. 8-11	+ .35
Do.	Clarendon, Ark.	Mouth..134	Mar. 20, 1890	36.63	— 9.88	Nov. 22, 1897	4.07	4.35	Oct. 10-11	+ .28
Yazoo	Yazoo City, Miss.	Mouth.. 65	1882	36.50	— 18.30	1875	— 4.30	— 1.80	Nov. 16-18	+ 2.50

a Discontinued.

TABLE No. 3.—*Highest gauge readings in 1902, to May 31, Mississippi River and tributaries.*

[For elevations and locations of gauges, etc., see Table No. 2.]

River.	Station.	Date.	Gauge reading.
			<i>Feet.</i>
Mississippi	St. Louis, Mo.	Mar. 17.	13.50
Do	Cape Girardeau, Mo.	Mar. 18.	16.30
Do	Cairo, Ill. (Ohio River) .	Mar. 17.	42.14
Do	Belmont, Mo.	do.	38.60
Do	New Madrid, Mo.	Mar. 18.	33.24
Do	Cottonwood Point, Mo.	Mar. 19.	32.80
Do	Fulton, Tenn.	Mar. 20.	29.55
Do	Memphis, Tenn.	Mar. 21.	30.90
Do	Mhoon Landing, Miss.	Mar. 21-22.	34.3
Do	Helena, Ark.	Mar. 23-24.	39.58
Do	Sunflower Landing, Miss.	Mar. 24.	38.75
Do	Mouth of White River, Ark.	Mar. 28.	43.30
Do	Arkansas City, Ark.	Mar. 28-29.	31.4
Do	Greenville, Miss.	Mar. 29.	36.06
Do	Lake Providence, La.	Mar. 29-30, Apr. 16-17.	34.96
Do	Vicksburg, Miss.	Apr. 17.	41.22
Do	St. Joseph, La.	Apr. 18.	37.15
Do	Natchez, Miss.	do.	40.25
Do	Red River Landing, La.	Apr. 18-20.	38.80
Do	Bayou Sara, La.	do.	31.7
Do	Baton Rouge, La.	Apr. 18-19.	29.40
Do	Plaquemine, La.	Apr. 19-20.	25.6
Do	Donaldsonville, La.	Apr. 19.	23.8
Do	College Point, La.	do.	19.50
Do	Carrollton, La.	Apr. 14, 18, 21.	13.35
Do	Fort Jackson, La.	Apr. 14.	6.35
Arkansas	Little Rock, Ark.	May 30.	19.60
Atchafalaya	Barbre Landing, La.	Apr. 20-21.	37.38
Cumberland	Nashville, Tenn.	Apr. 4.	46.20
Ohio	Cincinnati, Ohio.	Mar. 5.	50.9
Do	Louisville (Upper), Ky.	Mar. 9.	24.8
Do	Louisville (Lower), Ky.	do.	50.4
Do	Paducah, Ky.	Mar. 15.	39.7
Ouachita	Camden, Ark.	Apr. 1.	35.10
Red	Fulton, Ark.	Apr. 16-17.	21.80
Do	Shreveport, La.	Apr. 20.	16.80
Do	Alexandria, La.	Apr. 20-21.	19.75
St. Francis	Bridge, St. Louis, Iron Mountain and Southern Rwy.	Mar. 28-29.	15.8
Tennessee	Chattanooga, Tenn.	Mar. 4.	38.0
Do	Florence, Ala.	Mar. 29.	21.70
Wabash	Mount Carmel, Ill.	Mar. 4.	11.8
White	Jacksonport, Ark.	Mar. 2.	19.30
Do	Clarendon, Ark.	Apr. 6-7.	25.00
Yazoo	Yazoo City, Miss.	Apr. 21-22.	26.6

TABLE No. 4.—*Maximum high-water gauge readings in 1901, Mississippi River, Cairo, Ill., to Fort Jackson, La.*

[High water of 1897 is given for comparison.]

Number of high-water gauge.	Locality of regular gauge.	Distance from Cairo.	Date of observation (1901).	Regular gauge reading.	Elevation of water surface, Memphis datum.		Difference.	Slope per mile.
					1901.	1897.		
		<i>Miles.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
182	Cairo, Ill.	0.0	May 1-2.	43.20	320.9	329.4	8.5	.....
180	.....	4.4	May 1. ....	.....	319.3	326.5	7.2	0.359
	.....	12.5	May 2. ....	.....	317.4	324.2	6.8	.288
178	Belmont, Mo.	21.3	May 1.	39.80	313.5	318.8	5.3	.441
177	.....	27.5	May 2. ....	.....	311.8	316.5	4.7	.277
172	.....	33.5	.....	.....	309.4	314.2	4.8	.397
171	.....	59.5	May 3. ....	.....	301.7	306.4	4.7	.297
	.....	64.5	.....	.....	298.7	304.9	6.2	.600
170	New Madrid, Mo.	70.3	May 3.	34.21	296.8	302.9	6.1	.328
168	.....	73.3	.....	.....	296.2	300.8	4.6	.193
167	.....	84.8	.....	.....	290.0	296.3	6.3	.537
166	.....	89.5	May 3. ....	.....	286.8	293.1	6.3	.689
165	.....	96.0	.....	.....	283.87	289.9	6.1	.545
163	.....	99.3	.....	.....	282.3	288.0	5.7	.349
161	.....	109.3	May 2-4. ....	.....	276.8	283.3	6.5	.550
	.....	118.5	May 5. ....	.....	272.8	278.8	6.0	.429

TABLE No. 4.—Maximum high-water gauge readings in 1901, Mississippi River, Cairo, Ill., to Fort Jackson, La.—Continued.

Number of high-water gauge.	Locality of regular gauge.	Distance from Cairo.	Date of observation (1901).	Regular gauge reading.	Elevation of water surface, Memphis datum.		Difference.	Slope per mile.
					1901.	1897.		
		<i>Miles.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
159	Cottonwood Point, Mo.	123.0	May 3-4	33.85	271.4	276.8	5.4	.324
158		130.5			267.5	274.0	6.5	.519
156		135.0	May 4		266.4	273.0	6.6	.244
156		146.0	May 5		260.9	268.1	7.2	.500
156		162.8	May 3-4		257.2	264.0	6.8	.544
154		158.3	May 4		254.6	261.4	6.8	.464
153		161.8	May 5-6		253.0	260.2	7.2	.471
152		167.5			249.3	258.3	9.0	.649
151		172.8	May 6		246.6	254.8	8.2	.509
	Fulton, Tenn.	175.4	do	30.63	246.0	252.9	6.9	.212
150		180.1	May 5-6		244.1	251.2	7.1	.415
149		186.3			241.1	247.5	6.4	.454
147		197.3	May 5		237.8	243.8	6.0	.308
146		208.3	May 6		235.2	240.1	4.9	.428
145		208.0	May 4-6		233.3	239.4	5.1	.404
144		212.8			230.9	235.5	4.6	.500
142		225.5			224.4	229.3	4.9	.512
	Memphis, Tenn.	230.0	May 6	32.15	223.0	228.6	5.6	.313
141		235.0			221.2	225.1	3.9	.368
138		249.5			214.6	218.8	4.2	.455
137		256.3			209.4?	215.4	6.0	.765
135		266.8	May 6		206.9	211.8	4.9	.238
134		271.0	May 7		207.0?	210.8	3.8	.012
	Mhoon Landing, Miss.	276.3	May 7-8	35.4	203.8	210.0	6.2	.604
133		290.5	May 9		202.3	209.5	7.2	.336
131		289.5	May 7-8		197.3	206.6	9.3	.560
128		301.5			192.3	203.2	10.9	.417
	Helena, Ark.	306.5	May 8-9	41.45	190.3	200.6	10.3	.400
127		312.5	May 9		188.6	197.5	8.9	.283
126		317.8			187.2	195.2	8.0	.264
125		323.5			185.0	193.2	8.2	.386
124		329.3			183.5	190.9	7.4	.259
123		334.5			182.8	189.4	6.6	.185
122		339.0	May 9		180.1	185.8	5.7	.600
121		342.5	do		178.8	184.8	6.0	.371
120		346.8			176.7	183.1	6.4	.498
	Sunflower Landing, Miss.	352.7	May 8-10	40.5	174.4	181.1	6.7	.381
118		361.0	May 8		171.7	178.5	6.8	.296
117		366.7			167.5	176.5	9.0	.994
	Mouth White River.	393.2	May 11-12	44.7	160.3	168.0	7.7	.272
110		408.0			155.7	164.0	8.3	.311
109a		412.0			153.5?	162.9	9.4	.560
108		416.8	May 11		152.8	162.4	9.6	.146
106		427.0	May 11-12		150.0	159.7	9.7	.275
	Arkansas City, Ark.	438.3	May 12-13	43.3	146.6	155.2	8.6	.300
99		467.0			138.2	147.0	8.8	.298
	Greenville, Miss.	478.3	May 13	37.40	132.3	141.6	9.3	.525
94		495.3			127.3	136.9	9.6	.292
92		505.5			125.7	133.8	8.1	.157
86		537.5			114.4	122.3	7.9	.353
	Lake Providence, La.	542.3	May 14	36.45	112.9	120.9	8.0	.304
83		556.5	do		108.3	116.4	8.1	.325
	Vicksburg, Miss.	599.3	May 15-16	41.50	94.4	105.3	10.9	.325
67		642.8	May 16		77.8	88.7	10.9	.381
	St. Joseph, La.	648.3	May 15-16	36.90	76.5	87.5	11.0	.244
64		663.8			71.6	82.6	11.0	.314
	Natchez, Miss.	700.3	May 15-17	39.80	63.6	73.6	10.0	.221
	Red River Landing, La.	765.3	May 15-18	37.30	47.9	60.9	13.0	.240
	Bayou Sara, La.	799.8	May 16-18	30.40	41.6	54.6	13.0	.183
	Baton Rouge, La.	833.3	May 15-19	28.25	34.9	47.6	12.7	.201
	Plaquemine, La.	854.1	May 15, 17	24.45	32.0	44.2	12.2	.141
	Donaldsonville, La.	885.4	May 19	22.35	28.4	39.2	10.8	.113
	College Point, La.	904.5	May 16	18.60	26.0	36.1	10.1	.128
	Carrollton, La.	957.0	May 7, 9, 17, 20.	12.70	19.6	26.8	7.2	.120
	Fort Jackson, La.	1,039.0	May 8, 9, 18.	6.00	11.4	13.3	1.9	.101

TABLE No. 5.—Low-water slope, Mississippi River, Cairo, Ill., to Fort Jackson, La., 1901.

No. of high-water gauge.	Locality of regular gauge.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Slope per mile between stations.	Date of observation (1901).	Date of lowest stage, 1901, at regular gauges and readings.	
								Date (1901).	Gauge reading.
		<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>			<i>Feet.</i>
	Cairo, Ill.	0.0	284.93	-4.34	280.59	.....	Oct. 15	Nov. 28	2.88
182	4.4	284.07	-4.15	279.92	0.152	Oct. 16		
181	8.9	283.48	-3.94	279.54	.084	.....	
180	12.4	282.57	-3.76	278.81	.203	.....	
179	17.8	281.02	-3.54	277.48	.256	Oct. 17		
	Belmont, Mo	21.3	280.70	-3.39	277.31	.047	.....	Nov. 29	3.50
178	27.5	278.61	-3.28	275.33	.319	.....	
177	33.5	275.52	-3.18	272.34	.498	.....	
176	38.6	275.30	-3.09	272.21	.025	Oct. 18		
175	44.3	273.64	-2.99	270.65	.274	.....	
174	49.8	273.00	-2.89	270.11	.098	.....	
173	54.0	271.97	-2.82	269.15	.229	.....	
172	59.5	270.69	-2.72	267.97	.215	.....	
171	64.5	269.73	-2.64	267.09	.176	Oct. 19		
	New Madrid, Mo ..	70.3	268.39	-2.54	265.85	.214	.....	Nov. 29	3.26
170	73.3	267.28	-2.56	264.72	.377	Oct. 22		
169	78.8	264.10	-2.58	261.52	.582	.....	
168	86.0	258.28	-2.62	255.66	.814	.....	
167	90.4	255.92	-2.64	253.28	.541	.....	
166	95.4	252.58	-2.66	249.92	.672	Oct. 23		
165	99.2	250.84	-2.68	248.16	.463	.....	
164	103.7	247.79	-2.71	245.08	.684	.....	
163	109.2	245.07	-2.73	242.34	.498	.....	
162	113.4	243.37	-2.76	240.61	.412	Oct. 24		
161	118.4	241.92	-2.78	239.14	.294	.....	
	Cottonwood Point, Mo	122.5	240.04	-2.80	237.24	.463	.....	Nov. 29 (Dec. 1)	-0.30
160	127.7	238.54	-2.70	235.84	.269	Oct. 25		
159	130.7	235.07	-2.65	232.42	1.140	Oct. 26		
158	135.2	232.92	-2.56	230.36	.458	.....	
157	139.7	232.59	-2.47	230.12	.053	.....	
156	145.9	230.69	-2.36	228.33	.289	.....	
155	152.7	228.72	-2.22	226.50	.269	.....	
154	158.2	226.66	-2.12	224.54	.356	Oct. 27		
153	161.7	223.12	-2.06	221.06	.994	Oct. 28		
152	167.4	220.71	-1.95	218.76	.404	.....	
151	172.7	219.00	-1.86	217.14	.306	.....	Nov. 30 (Dec. 1)	1.55
	Fulton, Tenn	175.4	218.78	-1.81	216.97	.063	Oct. 29		
150	180.1	215.75	-1.76	213.99	.634	Oct. 31		
149	186.2	212.37	-1.69	210.68	.543	.....	
148	192.3	207.37	-1.62	205.75	.808	.....	
147	197.3	203.68	-1.57	202.11	.728	.....	
146	203.3	200.15	-1.50	198.65	.577	.....	
145	208.0	198.74	-1.45	197.29	.289	Nov. 1		
144	212.8	198.62	-1.40	197.22	.015	.....	
143	220.3	195.61	-1.31	194.30	.389	.....	
142	225.5	193.38	-1.25	192.13	.417	.....	
	Memphis, Tenn	230.0	191.74	-1.20	190.54	.353	Nov. 4	Dec. 1-2	-0.30
141	235.0	188.55	-1.23	187.32	.644	Nov. 6		
140	239.5	186.26	-1.26	185.00	.516	.....	
139	243.5	185.07	-1.29	183.78	.305	.....	
138	249.5	181.40	-1.33	180.07	.618	.....	
137	256.2	176.87	-1.37	175.50	.682	Nov. 7		
136	261.2	174.76	-1.40	173.36	.428	.....	
135	266.7	173.27	-1.44	171.83	.278	.....	
134	271.0	171.15	-1.47	169.68	.500	.....	
	Mhoon Landing, Miss	276.3	166.13	-1.50	164.63	.968	.....	Nov. 30	-3.72
133	280.5	163.30	-1.42	161.88	.655	Nov. 9		
132	284.3	162.44	-1.34	161.10	.205	.....	
131	289.5	159.48	-1.23	158.25	.548	.....	
130	293.5	157.63	-1.15	156.48	.442	.....	
129	297.7	153.68	-1.07	152.61	.921	Nov. 10		
128	301.5	153.43	-.99	152.44	.045	.....	
	Helena, Ark	306.5	151.19	-.89	150.30	.428	Nov. 11	Dec. 2	1.45
127	312.6	149.35	-.86	148.49	.297	Nov. 12		
126	317.8	147.45	-.84	146.61	.362	Nov. 13		
125	323.6	146.06	-.81	145.25	.234	.....	
124	329.3	145.80	-.78	145.02	.040	.....	
123	334.5	142.80	-.76	142.04	.573	.....	
122	339.0	141.50	-.73	140.77	.282	.....	
121	342.5	140.50	-.72	139.78	.283	.....	
120	346.7	140.45	-.70	139.75	.007	.....	

TABLE No. 5.—Low-water slope, Mississippi River, Cairo, Ill., to Fort Jackson, La., 1901—Continued.

No. of high-water gauge.	Locality of regular gauge.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Slope per mile between stations.	Date of observation (1901).	Date of lowest stage, 1901, at regular gauges and readings.	
								Date (1901).	Gauge reading.
		<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>			<i>Feet.</i>
	Sunflower Land- ing, Miss	352.7	137.47	-0.67	136.80	0.492	Nov. 14	Dec. 3-4	2.85
119	357.0	136.72	— .65	136.07	.170	Nov. 16	.....	.....
118	362.0	133.82	— .62	133.20	.574	do ..	.....	.....
117	366.8	132.05	— .59	131.46	.362	do ..	.....	.....
116	371.8	128.23	— .57	127.66	.760	do ..	.....	.....
115	378.0	127.13	— .53	126.60	.171	do ..	.....	.....
114	383.5	124.28	— .50	123.78	.513	do ..	.....	.....
113	389.5	121.62	— .47	121.15	.438	do ..	.....	.....
	Mouth White River	393.2	120.60	— .45	120.15	.270	Nov. 18	Dec. 2-4	4.55
112	398.4	119.65	— .44	119.21	.181	Nov. 19	.....	.....
111	401.7	119.02	— .43	118.59	.188	do ..	.....	.....
110	407.9	117.37	— .41	116.96	.263	do ..	.....	.....
109a	412.0	116.15	— .40	115.75	.295	do ..	.....	.....
108	416.8	115.46	— .39	115.07	.142	Nov. 20	.....	.....
107	421.5	113.36	— .38	112.98	.445	do ..	.....	.....
106	427.0	110.18	— .37	109.81	.576	do ..	.....	.....
105	432.5	109.20	— .35	108.85	.175	do ..	.....	.....
	Arkansas City, Ark.	438.3	104.65	— .34	104.31	.783	Nov. 21	Nov. 29- Dec. 4	1.00
104	444.7	103.71	— .35	103.36	.148	Nov. 22	.....	.....
103	449.4	103.26	— .36	102.89	.100	Nov. 23	.....	.....
102a	453.9	102.60	— .37	102.23	.147	do ..	.....	.....
101	458.9	100.64	— .37	100.27	.392	do ..	.....	.....
100	463.3	100.59	— .38	100.21	.014	do ..	.....	.....
99	466.8	98.88	— .38	98.50	.489	do ..	.....	.....
98	473.3	97.45	— .39	97.06	.222	do ..	.....	.....
	Greenville, Miss ..	478.3	96.12	— .40	95.72	.268	do ..	Dec. 3-4	.85
97	482.5	95.21	— .39	94.82	.214	Nov. 25	.....	.....
96	487.0	93.22	— .38	92.84	.440	do ..	.....	.....
95a	489.8	90.73	— .37	90.36	.886	do ..	.....	.....
94	495.4	89.08	— .36	88.72	.293	Nov. 26	.....	.....
93a	500.6	88.56	— .34	88.22	.096	do ..	.....	.....
92	505.2	86.77	— .33	86.44	.387	do ..	.....	.....
91	510.2	85.79	— .32	85.47	.194	do ..	.....	.....
90a	516.8	83.21	— .31	82.90	.389	do ..	.....	.....
89	522.3	82.05	— .29	81.76	.207	do ..	.....	.....
88	525.6	81.16	— .28	80.88	.267	Nov. 27	.....	.....
87	531.4	79.41	— .27	79.14	.300	do ..	.....	.....
86	537.5	78.22	— .25	77.97	.192	do ..	.....	.....
	Lake Providence, La	542.3	74.88	— .24	74.64	.694	do ..	Dec. 4-6	— .85
85	546.5	71.99	— .24	71.75	.688	Nov. 28	.....	.....
84	552.2	70.87	— .24	70.63	.196	Nov. 29	.....	.....
83	556.5	70.52	— .23	70.29	.079	do ..	.....	.....
82	561.2	69.13	— .23	68.90	.296	do ..	.....	.....
81	568.0	64.67	— .23	64.44	.509	do ..	.....	.....
80	573.5	60.79	— .22	60.57	.704	do ..	.....	.....
79	578.0	58.87	— .22	58.65	.427	do ..	.....	.....
78a	583.0	57.19	— .22	56.97	.336	Nov. 30	.....	.....
77	588.5	54.80	— .21	54.59	.433	do ..	.....	.....
76	593.5	51.99	— .21	51.78	.562	do ..	.....	.....
	Vicksburg, Miss ..	599.3	50.80	— .21	50.59	.205	do ..	Dec. 5	-2.32
75	602.8	49.53	— .23	49.30	.369	Dec. 1	.....	.....
74	607.5	49.27	— .25	49.02	.060	do ..	.....	.....
73	612.5	46.88	— .28	46.60	.484	Dec. 2	.....	.....
72	617.5	43.46	— .30	43.16	.688	do ..	.....	.....
71	621.9	40.79	— .33	40.46	.614	do ..	.....	.....
70	627.4	39.42	— .35	39.07	.253	do ..	.....	.....
69	632.9	38.41	— .38	38.03	.189	do ..	.....	.....
68	637.9	37.27	— .41	36.86	.434	do ..	.....	.....
67	642.7	35.68	— .43	35.25	.335	Dec. 3	.....	.....
	St. Joseph, La.	648.3	34.20	— .46	33.74	.270	do ..	Dec. 1	-5.87
66	655.3	33.57	— .41	33.16	.083	do ..	.....	.....
65	659.8	31.48	— .37	31.11	.456	Dec. 4	.....	.....
64	663.8	30.99	— .34	30.65	.115	do ..	.....	.....
63	680.8	30.07	— .31	29.76	.178	do ..	.....	.....
62	686.6	29.87	— .26	29.61	.026	do ..	.....	.....
61	691.6	28.78	— .23	28.55	.212	do ..	.....	.....
60	694.1	27.70	— .21	27.49	.424	do ..	.....	.....
	Natchez, Miss.	700.3	25.97	— .16	25.81	.271	Dec. 5	Dec. 6	2.05
59	705.5	25.70	— .18	25.52	.056	do ..	.....	.....
58	711.3	22.00	— .21	21.79	.643	do ..	.....	.....
57	716.0	19.67	— .23	19.44	.500	do ..	.....	.....

TABLE NO. 5.—*Low-water slope, Mississippi River, Cairo, Ill., to Fort Jackson, La., 1901—Continued.*

No. of high-water gauge.	Locality of regular gauge.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Slope per mile between stations.	Date of observation (1901).	Date of lowest stage, 1901, at regular gauges and readings.	
								Date (1901).	Gauge reading.
	Natchez, Miss.—Continued.	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>			<i>Feet.</i>
56	.....	720.5	18.71	— .25	18.46	.218	Dec. 6	.....	.....
55	.....	725.3	17.43	— .27	17.16	.271	.....do.....	.....	.....
54	.....	731.0	16.29	— .29	16.00	.204	.....do.....	.....	.....
53	.....	737.5	15.87	— .32	15.55	.069	.....do.....	.....	.....
52	.....	742.7	15.06	— .34	14.72	.160	.....do.....	.....	.....
51a	.....	747.5	14.69	— .36	14.33	.081	.....do.....	.....	.....
50	.....	751.5	14.37	— .38	13.99	.085	.....do.....	.....	.....
49	.....	756.0	13.96	— .40	13.56	.096	.....do.....	.....	.....
48	.....	761.0	13.72	— .42	13.30	.052	Dec. 7	.....	.....
	Red River Landing, La.	765.3	13.08	— .44	12.64	.153	.....do.....	Nov. 18, 30.	2.00
	Bayou Sara, La.	799.8	9.82	.....	9.82	.082	.....	Nov. 24—25.	—1.40
	Baton Rouge, La.	833.3	7.95	.....	7.95	.056	.....	Nov. 25	1.30
	Plaquemine, La.	854.1	7.51	.....	7.51	.021	.....do.....	.....	.00
	Donaldsonville, La.	885.4	7.18	.....	7.18	.011	.....do.....	.....	1.12
	College Point, La.	904.5	6.89	.....	6.89	.015	.....do.....	.....	— .47
	Carrollton, La.	957.0	6.95	.....	6.95	.001	.....	Dec. 18, 21.	.01
	Fort Jackson, La.	1,039.0	6.09	.....	6.09	.010	.....	Nov. 25	.70

NOTE.—Below Red River Landing only the regular gauges are given.

TABLE No. 6.—*Results of discharge observations, Mississippi River.*

AT COLUMBUS, KY.

Date.	Gauges.			Cross section of discharge.						Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.	
	Belmont.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.		Width.	Scour or fill.							
				Water.	Below datum.	Mean.	Mean datum.									Maxi- mum.
1901.				<i>Sq. feet.</i>	<i>Sq. feet.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Sq. feet.</i>	<i>Fect.</i>	<i>Cu. feet.</i>					
Nov. 16, a. m.	3.98	<i>Fect.</i>	0.00	67,898	67,898	27.3	27.3	43.7	2,468	—	1.61	106,681	F.	11	38	X. brisk.
Nov. 16, p. m.	3.95	.....	.....	69,076	69,160	28.0	28.0	43.7	2,468	+1,752	1.58	109,010	F.	11	36	Do.
Nov. 17, a. m.	3.92	.....	.....	67,244	67,342	27.5	27.3	43.6	2,444	—1,808	1.53	108,097	F.	13	39	VI. light.
Nov. 17, p. m.	3.90	.....	.....	67,232	67,375	27.8	27.3	43.2	2,420	+383	1.63	109,503	F.	12	42	X and XI. light.
Nov. 18, a. m.	3.90	.....	.....	68,392	68,515	28.5	27.8	43.6	2,396	+1,140	1.63	111,778	F.	12	40	XI. light, and XII. light to brisk.
Nov. 18, p. m. ....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov. 19, a. m.	3.85	.....	.....	67,597	67,937	28.2	27.5	43.6	2,396	—	1.62	109,441	F.	12	46	IX. light and calm.
Nov. 19, p. m.	3.84	.....	.....	67,816	68,166	28.4	27.6	43.6	2,388	+219	1.61	109,454	F.	13	46	XI. light and calm.
Nov. 20, a. m.	3.80	.....	.....	69,382	69,704	29.0	28.3	43.6	2,396	+1,638	1.44	100,084	F.	12	48	VI. light.
Nov. 20, p. m.	3.78	.....	.....	69,196	69,684	28.9	28.2	43.6	2,396	+210	1.54	106,453	F.	11	44	Calm.
Nov. 21, a. m.	3.75	.....	.....	67,776	68,257	28.3	27.7	43.6	2,396	+1,327	1.48	100,218	F.	11	44	IV. light.
Nov. 21, p. m.	3.72	.....	.....	69,042	69,524	28.8	28.2	45.2	2,396	+1,267	1.58	109,350	F.	11	53	XI. light and calm.
Nov. 25, a. m.	3.72	.....	.....	68,636	69,118	28.6	28.0	44.2	2,396	+406	1.53	105,190	M.	12	37	Calm.
Nov. 26, a. m.	3.72	.....	.....	70,731	71,213	29.6	28.8	45.2	2,396	+2,065	1.48	104,769	F.	11	47	VI. light.
Nov. 26, p. m.	3.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nov. 27, a. m.	3.71	.....	.....	69,217	69,795	28.9	28.3	44.2	2,396	—1,418	1.47	101,615	M.	12	43	Calm.

The discharge section was at same place as in 1900. The Kentucky end was about 1,000 feet above the railroad warehouse, and the Missouri end of the section was about 2,750 feet below the Belmont grain elevator.

Discharges marked F were observed with double floats; the lower float was run at mid depth. Those marked M were observed with Haskell meter at six-tenths depth.

The zero of the regular M. R. C. gauge at Belmont, whose readings are tabulated, is 286.85 feet above the Cairo datum plane. The elevation of the local gauge, on left bank at discharge section, was not determined.

Datum line was taken at 3.90 feet on the local gauge as observed November 18, when the Belmont gauge read 3.98 feet.

Direction of wind is recorded as from a clock dial, XII o'clock denoting wind blowing downstream.

AT HELENA, ARK.

Date.	Gauges.			Cross section of discharge.						Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.	
	Helena.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.										
				Water.	Sq. feet.	Below datum.	Mean.	Mean datum.	Max. mum.							Width.
1901.				Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Obs. feet.					
December 3, a. m.	Feet. 1.50	Feet. 1.50	+0.02	51,070	51,634	31.7	32.1	49.0	1,610	.....	2.19	F.	10	137		XI, light.
Do.	.....	1.50	.....	.....	.....	.....	.....	.....	.....	.....	1.87	M.	10	.....		Do.
December 3, p. m.	1.53	1.50	.....	.....	.....	.....	.....	.....	.....	.....	1.83	M.	10	.....		XII, light.
Do.	.....	1.50	.....	.....	.....	.....	.....	.....	.....	.....	1.96	M.	10	.....		Do.
December 4, a. m.	1.65	1.60	+ .15	53,170	53,572	33.0	33.3	50.8	1,610	+1,938	2.10	F.	10	68		Do.
Do.	.....	1.60	.....	.....	.....	.....	.....	.....	.....	.....	1.96	M.	10	.....		Do.
December 4, p. m.	1.70	1.68	.....	52,238	52,512	32.4	32.6	49.8	1,610	-1,060	2.03	M.	10	95		II, light.
Do.	.....	1.68	.....	.....	.....	.....	.....	.....	.....	.....	2.19	F.	10	.....		Calm.
Do.	.....	1.68	.....	.....	.....	.....	.....	.....	.....	.....	2.05	F.	9	.....		Do.
December 5, p. m.	1.85	1.85	+ .15	52,985	52,985	32.9	32.9	49.8	1,610	+ 473	2.22	F.	10	35		XII, very light.

The discharge section was at same place as in 1898, about one-half mile below Helena.

Discharges marked "M" were observed with Haskell meter, run at six-tenths depth; those marked "F" were observed with double floats, the lower float at mid depth.

The zero of the regular gauge at Helena, whose readings are tabulated, is 161.98 feet above the Cairo datum plane. The elevation of the local gauge at section was not determined.

The datum line was taken at 1.85 feet on the gauge, as observed December 5.

Area of December 3 derived from four sets of soundings; those of December 4 derived from two and three sets, respectively.

TABLE No. 6.—*Result of discharge observations, Mississippi River—Continued.*

AT ARKANSAS CITY, ARK.

[Upper section.]

Date.	Gauges.			Cross section of discharge.						Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.	
	Arkansas City.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			Scour or fill.							
				Water.	Below datum.	Mean.	Mean datum.	Maxi- mum.								Width.
1901	<i>Fed.</i>	<i>Fed.</i>	<i>Fed.</i>	<i>Sq. feet.</i>	<i>Sq. feet.</i>	<i>Fed.</i>	<i>Fed.</i>	<i>Fed.</i>	<i>Fed.</i>	<i>Sq. feet.</i>	<i>Cubic feet.</i>					
December 8, a. m.	1.4	1.40	+0.2	43,418	43,988	16.7	16.9	2,598	2.74	118,766		M.	11	110		II, breeze; III, light.
Do.	.....	1.40	.....	.....	.....	.....	.....	.....	2.71	117,520		M.	11	.....		IV, light breeze.
December 9, p. m.	1.6	1.40	.....	.....	.....	.....	.....	.....	2.74	119,069		M.	12	.....		II, very light.
December 9, a. m.	1.6	1.60	+ .2	45,224	45,224	17.4	17.4	2,598	2.90	130,946		F.	11	48		VIII, light to light breeze.

[Lower section.]

December 9, p. m.	1.7	1.60	.....	48,453	48,548	25.6	25.7	61.3	2.61	<i>M.</i>	11	42	VIII, light.
December 10, a. m.	1.8	1.65	+0.2	47,994	47,994	25.4	25.4	60.1	2.62	<i>F.</i>	9	128	Calm; IV, light.
Do.	.....	1.65	.....	.....	.....	.....	.....	.....	2.70	<i>F.</i>	10	.....	Calm; IV, light.
Do.	.....	1.65	.....	.....	.....	.....	.....	.....	2.66	<i>M.</i>	10	.....	III, light.
December 10, p. m.	1.9	1.65	.....	.....	.....	.....	.....	.....	2.67	<i>M.</i>	10	.....	VI, brisk, light breeze.
Do.	.....	1.65	.....	.....	.....	.....	.....	.....	2.49	<i>M.</i>	10	.....	IV, very light.

Upper discharge section was about one-half mile below Arkansas City; it was identical with that of 1898, except that right bank end was 630 feet farther downstream, making it about 700 feet below lower sawmill. Lower discharge section was about 1,800 feet from upper section; was more nearly normal to direction of flow, and considered better adapted for observations.

Discharges marked M observed with Haskell meter run six-tenths depth; those marked F observed with double floats, lower mid-depth.

Zero of regular M. R. C. gauge at Arkansas City, whose readings are tabulated, is 116.44 feet above Cairo datum plane; a single line of levels from regular gauge makes the local gauge, which was at upper section 0.02 foot higher than the former. Datum line for upper section was at 1.60 feet on local gauge and at 1.65 feet for lower section.

The section was sounded for each set of velocity observations; three sets of soundings were combined for December 8, and four sets for December 10 areas.

TABLE No. 7.—Results of discharge observations, Cumberland River, near Rockwell, Ky.

Date.	Local gauge.	Cross section of discharge.							Scour or fill.	Mean velocity per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Num-ber of sta-tion-ings.	Direction and force of wind.
		Area.		Depth.			Width.								
		Water.	Below datum.	Mean.	Mean datum.	Maxi-mum.									
Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cu. feet.	Cu. feet.	Cu. feet.			
1902.															
April 5, a. m.	9.00	31,361	32,493	38.8	38.4	57.7	808	4.865	132,576	3,557	136,133	M.	7	57	XII, very light.
April 5, p. m.	9.18	31,506	32,493	39.0	38.4	57.9	808	4.913	154,801	3,727	158,528	M.	5	57	Do.
Do.	9.29	31,565	32,493	39.1	38.4	60.0	808	4.778	150,967	3,812	154,779	M.	5	57	Do.
April 6, a. m.	9.70	31,696	32,263	39.2	38.2	58.5	808	4.837	153,311	3,973	157,284	F.	7	36	VI, light.
Do.	9.75	31,757	32,263	39.3	38.2	58.6	808	4.855	154,082	4,013	158,095	M.	7	36	V, light.
April 6, p. m.	9.82	31,793	32,263	39.4	38.2	58.6	808	4.841	153,990	4,056	157,986	F.	7	36	IV, light.
April 7, a. m.	10.30	32,252	32,327	38.6	38.3	60.1	835	4.944	159,448	4,397	163,845	M.	5	31	VI, breeze.
April 8, a. m.	10.39	32,793	32,793	38.8	38.8	59.3	845	4.676	153,847	4,738	158,085	M.	5	32	VIII, breeze.
Do.	10.39	32,793	32,793	38.8	38.8	59.3	845	4.797	157,316	4,738	162,054	F.	8	32	VI, breeze.

There appeared to be a body of slack water near the right bank; no velocity could be detected at the surface 50 feet from this river bank. The depth at this point was about 26 feet, but no velocity observation was made below the surface.

One set of soundings was taken each day; when more than one discharge was measured on one day areas were derived from this set of soundings.

Over-bank discharge was measured on April 5, 6, and 8; all over-bank discharges derived from these.

Observations marked "M" were taken with Haskell meter at six-tenths depth. Observations marked "F" were taken with double floats, the lower float being at mid depth.

APPENDIX 1 C.

REPORT OF ASSISTANT ENGINEER C. W. STURTEVANT ON CARE AND REPAIR OF PLANT AND DREDGING OPERATIONS ON THE MISSISSIPPI RIVER BETWEEN HEAD OF THE PASSES AND THE MOUTH OF THE OHIO RIVER.

UNITED STATES DREDGE FLEET,
West Memphis, Ark., December 31, 1901.

CAPTAIN: I have the honor to submit the following report upon the operations of the United States dredge fleet engaged in deepening the channel of the Mississippi River from the Head of the Passes to the mouth of the Ohio River during the period commencing April 1, 1901, and ending December 31, 1901:

PROJECT.

The operations of the year include the care and repairs to plant, testing new dredges, and the field operations of the dredges in maintaining a channel 9 feet in depth and 250 feet in width from Cairo, Ill. (0), downstream as far as dredging may be necessary.

During the high-water season, when dredging is not necessary, the plant is assembled in one fleet for its care and repair. Only the necessary force to do this is retained. At the commencement of the low-water season the fleet is divided into separate plants for work, each dredge being accompanied by a tender, pile sinker, floating discharge pipe, and plunder barge. The self-propelling dredges do not have a towboat or a pile sinker.

Three survey parties are organized, each party being quartered on one of the small steamboats to make surveys at all shoal crossings where dredging is necessary or likely to be required. The superintendent of dredging operations is provided with a suitable boat for making frequent trips over the field covered by the fleet, so that he may inspect the working of the different parties and properly locate the dredging by personal examination of the maps and the channels themselves, all crossings being carefully sounded and surveys ordered where necessary.

CARE OF PLANT.

During the past year the following plant pertaining to the improvement of the Mississippi River has been cared for at West Memphis, Ark. (234), about 2 miles below the railroad bridge across the Mississippi River at Memphis:

Dredges: <i>Alpha, Beta, Gamma, Delta, Epsilon, Zeta, Iota, Kappa, and Henry Flad.</i>	9
Steamboats: <i>Mississippi, Minnetonka, Sachem, Choctaw, Nokomis, Wynoka, Leota, Search, Patrol, Vulcan, Venus, Mercury, and Mars</i>	13
Pile sinkers: Nos. 21, 61, 971, 981, 982, 983, and 984	7
Quarter boats: Store boat No. 13, quarter boat No. 154 (Third district), and office boat <i>Illinois</i>	3
Barges: Nos. 208, 211, 215, and 228	4
Small sunk-deck flat	1
Calking flat	1

Barges Nos. 9319 and 9404, property of the First and Second districts, have been used for plunder barges at the fleet.

The steamer *Vulcan* has been used as a fleet tender during the lay-up season.

In the month of April, during the high stage of water, the *Alpha* was beached on the bank above the fleet, and the principal part of the machinery removed.

The steamer *Mississippi* left the fleet on April 1 and returned on April 24, having made the first semiannual inspection trip of the Mississippi River Commission. The *Mississippi* was again used for the second semiannual inspection trip, and left the fleet on October 27 and returned on November 23.

A small party with the survey steamer *Mars* and pile sinker 984 left the fleet on May 21 to care for the season's fuel at Cherokee Crossing (90). This party was returned to the fleet on November 27.

The steamer *Patrol* left the fleet on October 10 for the low-water gauge inspection trip.

The steamer *Mercury* left the fleet on November 19 for low-water discharge work.

The new self-propelling dredges *Kappa* and *Henry Flad* arrived at the fleet on July 10, 1901.

The dredge *Beta*, in tow of the steamer *Sachem*, with the necessary accompanying plant, returned from South Pass on July 27, 1901.

Miscellaneous.—The work of care of plant at the fleet consisted in tying up and sparring out the plant, painting smokestacks, cleaning, oiling, and painting the inside of hulls, and the checking of property.

REPAIRS TO PLANT.

Dredge Beta.—During the lay-up period this dredge was employed at South Pass in deepening the ship channel at that place. No repairs except those incidental to its services were made during the season.

Dredge Gamma.—The remodeling of the suction head so as to dredge to a depth of 20 feet, which was under way at the beginning of this period, was finished. The pump received a new set of liners. The piston head of the air pump had new wrought-iron rings shrunk in place and turned down to fit the cylinder. Some broken draw-bars on the pontoons were removed and welded. The roof and the cabin were painted and the quartz in the filter was removed and washed.

Dredge Delta.—The old head block was removed, and the sides of the well increased in length and a new head block put in place, which was made by cutting off each end of the old head block that was originally on the *Beta*. This change was made necessary to allow the construction of a longer suction, which would excavate to a depth of 20 feet and would work either forward or backward. The electric-light plant and the machine tools were moved from the forward end of the boat to the back end of the engine room to make a place for the set of jet pumps, as the new suction which is being built for this boat is to use hydraulic jets instead of cutters. A new cylinder head was made for the port capstan engine. The jet pumps have been received, but have not yet been put in place. The suction hoisting frame has had additional hog-chain braces put in place to hold up the additional weight due to the heavy construction of the new suction. As it was impossible to finish the remodeling of this boat in time for field service, the work was stopped on account of the scarcity of labor and mechanics. The fair leads for the head cables have been received, but are not in place. The telescopic elbows for the jet pipe have been received and attached to the bow of the boat.

Dredge Epsilon.—The cabin and the roof have been painted. The boiler-deck guards have been covered with canvas and painted. A new sheet was placed in the port boiler of the starboard battery.

Dredge Zeta.—The cabin and the roof have been painted. The boiler-deck guards have been covered with canvas and painted.

Dredge Iota.—A wooden waterway was placed around the cabin on the main deck to keep rain water out of the engine room. The bulkheads of the wheelhouses were repaired and strengthened. The roof and cabin were painted. The work of remodeling the *Iota's* pontoons so as to give additional buoyancy and width of beam to the air chambers, for increase of stability, which work was under way at the beginning of this period by the contractor, was finished. The propelling wheels were thoroughly overhauled, and the name of the boat was painted on the wheelhouses. An oil tank for the distribution of cylinder oil by steam pressure was made and placed on the boat. Four wrought-iron knee fenders were built and placed on the boat, two on either side. The floor in the forward part of the cabin has been covered with linoleum.

Steamer Mississippi.—Minor repairs to suction shoe, heater coil, and water-works pump were made. The starboard crank pin on the propelling wheel was replaced by a new one. New breeching was made and put in place and the stumps sand-blasted and painted. The stovepipes were overhauled and the old heating system was removed from the boat and a new one installed. The cavels, plank-sheer, and nosing were repaired, and the outside of the hull, the roof, and a part of the outside of the cabin were painted.

Steamer Minnetonka.—As the services of this boat were not required, only minor repairs were made to the hull, such as were necessary to keep it afloat.

Steam tenders Sachem, Choctaw, Nokomis, Wynoka, and Leota.—These boats had their cabins painted and a few minor repairs made to machinery. Also some new fenders were made, and the propelling wheels were all thoroughly overhauled.

Steamer Search.—A new mud drum was made for the boilers. The outside of the cabin and the roof were painted. A new electric-light plant was installed on the boat with searchlight, drop light, and incandescent lights. The upper part of the bow stem was found to be rotten and was replaced temporarily by a new piece. The hull of this boat will require extensive repairs next season.

Steamer Patrol.—New breeching for the boilers was made and put in place. The roof was repaired and painted and both the outside and inside of the cabin were painted. A new blow-off nozzle was riveted on the steam drum, as the material of

the drum about the old nozzle had wasted away. The wheel was thoroughly overhauled. The hull was calked and painted and new shells were made for the heaters.

Small tenders Vulcan, Venus, Mars and Mercury.—The wheels of these boats were overhauled. The roofs and cabins were painted. Some new fenders were made and put in place, and the machinery received only minor repairs. One of the rudder stocks of the steamer *Venus* was broken and replaced by a new one. The bottom of the breeching on the *Mercury* had rusted out and the sheet iron was renewed.

Pile sinker No. 21.—The old hull of this boat has received minor repairs, so that it can be used as a plunder barge. The cabin had previously been removed.

Pile sinkers Nos. 61, 971, 981, 982, 983, and 984.—These boats had their hulls calked and painted and the roofs painted. The bracing of the leads received minor repairs.

Quarterboats No. 13, No. 154, and Illinois.—These boats had their hulls calked above the water line, and the roof of the *Illinois* was painted.

Barges.—Nos. 208, 211, 215, and 228 received such repairs to the hulls as were necessary to keep them in service with very light loads. These barges are very old and will soon have to be abandoned.

Small sunk deck flat.—The hull of this barge was calked and repaired above the water line, to be used about the fleet in the transfer of machinery. This barge is very old and will soon have to be abandoned.

Miscellaneous.—All the boilers on the fleet were carefully inspected and tested with hydrostatic pressure equal to 50 per cent additional to the pressure allowed by law and carried while at work in the field, after which the repairs to the boilers, mentioned previously in this report, were made.

TESTING NEW DREDGES.

The new self-propelling dredges *Kappa* and *Henry Flad* arrived at Cairo, Ill., on July 7, 1901, where a Government crew was placed on board and steam raised on the *Flad*, the *Kappa* being taken in tow. The dredges arrived at West Memphis, Ark. (234), on July 10, where they were placed out on the sand bar and tested. In the main the dredges were found to be in good shape, work only being delayed by the constant leaking of the joints of the ammonia pipes of the refrigerating plants and the adjusting of the governors of the main engines. The trouble with the governors of the main engines was finally remedied by interchanging the starboard and port fly wheels and revolving each fly wheel about 90 degrees from its previous position on the shaft. Three hundred feet of the discharge pipe of the dredge *Iota* was used in testing these dredges, their own ponton lines not having yet been constructed. To enable these dredges to be used during the past dredging season, each dredge was fitted up with 600 feet of floating pipe, 500 feet of the *Delta's* pipe being used on each dredge and a 100-foot joint from the *Beta's* pipe being used to connect the *Delta's* pipe to the dredge, the form of the *Beta's* pipe being such that one end could be lifted to the height of the discharge pipes of the *Kappa* and *Henry Flad*.

DREDGING OPERATIONS.

The operations of the dredge fleet during the low-water period of 1901 consisted in dredging all shoal crossings in the Mississippi River below the mouth of the Ohio River at Cairo, Ill. (0). The river was divided into three districts, as follows: The upper district extended from Cairo, Ill. (0), down to and including Miss Hickmans Crossing (131). The middle district extended from Miss Hickmans Crossing down to and including the shoal in the bend of Island 35, known as Random Shot Crossing (192). The lower district extended from Random Shot downstream as far as any work might be found necessary. The lowest point where any dredging was done to increase the depth of the channel was at Peters Towhead Crossing (270), just above Ashley Point. Each district was constantly patrolled by one of the survey parties quartered on one of the small steamers. Two dredges were assigned to do the work in each of these districts, the *Gamma* being held at the fleet at West Memphis in reserve, to be used wherever necessary. The steamer *Search* was used as an inspection boat and made soundings over the entire portion of the river where any shoals were reported and carried all supplies and stores from Memphis to the parties in the field.

The dredges *Epsilon* and *Iota* were placed in the upper district, which was patrolled and surveys made when found necessary by the steamer *Venus*. From reconnaissance made in the early part of the season's work, it was found that the largest amount of dredging in one locality would be in the vicinity of Island 34 (178). Therefore the *Beta*, the dredge of largest capacity, and the dredge *Zeta* were placed in the middle

district, this district being patrolled and surveyed by the party on the steamer *Vulcan*. The dredges *Kappa* and *Henry Flad* were placed in the lower district, with the survey boat *Mars*. As these dredges were enabled to keep good channels at all crossings, the *Gamma* was temporarily transferred to the engineer officer in charge of the Third district for experimental work in deflecting the channel near Lake Providence, La. (543).

The dredged channels were buoyed with barrel buoys, black buoys being placed on the right-hand and red ones on the left-hand side of the channel going downstream.

The dredge *Alpha* has been abandoned as a dredge on account of its decayed hull, and the *Delta* was not available, as the remodeled suction had not yet been constructed. During the latter part of the season, when it was thought advisable to withdraw from the field one dredge from each district, both the *Zeta* and the *Beta* were returned to winter quarters from the middle district and the *Iota* transferred from the first district to the middle district, leaving one dredge in each district.

DESCRIPTION OF WORK BY DREDGES.

Dredge Beta.—This dredge, in tow of the steamer *Sachem*, with pile sinker, fuel barge, and 1,800 feet of floating pipe, left the fleet on August 4. The dredge was tied up at the bank at Morgans Point (182) on August 6, while the steamer *Sachem* went to Cherokee (90) after four barges of coal. On August 10 dredging was commenced at what is known as Hatchie Island crossing (181). Work continued with minor delays until August 15, when the starboard cable pulled out both journals of the countershaft of its winding engine. The dredge was then swung out of the channel and temporary repairs were finished on August 16. Owing to a slight rise in the river and the increased channel depth due to the work, dredging was not resumed until September 10. Work made excellent progress until September 15, when the dredging necessary to be done at that crossing had been finished and the dredge was moved upstream about 1 mile to what is known as Hatchie River crossing (180), where dredging was at once commenced. Work made good progress until finished on September 22, when the dredge was anchored near the channel to await a lower stage of the river. On October 6 dredging was again resumed on this crossing and was finished on October 9. The dredge was again swung out of the channel to await a lower stage of the river. During this interval the boilers were cleaned. On October 11 the *Beta* was moved back to Hatchie Island crossing and work resumed. The necessary work was finished on October 14 and the dredge was moved out of the channel to await a lower stage of the river.

From survey of Hatchie Island crossing, made on October 19, five days after dredging, there was a channel 12½ feet deep, 80 feet wide, an 11½-foot channel 200 feet wide, and a 9½-foot channel 450 feet wide.

A survey of Hatchie River crossing, made on October 19, ten days after dredging, shows an 11½-foot channel 100 feet wide and a 9½-foot channel 350 feet wide.

On November 5 the dredge was moved up to Hatchie River crossing (180) and dredging was again commenced on November 6. Work continued at this place with minor delays, due to shortage of labor and drift encountered in the material dredged. The work necessary at this place was finished on November 10.

Map of Hatchie River crossing on November 14, four days after dredging, shows an 11-foot channel 150 feet wide and a 9-foot channel 250 feet wide.

On November 11 the dredge was moved down to what is known as Morgans Point crossing (182). Owing to the grounding of the boat while being moved and the shortage of labor, dredging was not commenced at Morgans Point until November 13. Work made good progress until completion, on November 15. Survey of Morgans Point on November 17, two days after dredging, shows an 11-foot channel 200 feet wide and a 9-foot channel 325 feet wide.

On November 24 the *Beta* and its accompanying plant left Morgans Point for winter quarters at the dredge fleet at West Memphis, Ark. (234), and arrived there the next day.

Dredge Epsilon.—This dredge, in tow of the steamer *Nokomis*, with pile sinker, plunder barge, and 1,000 feet of floating pipe, left the fleet at West Memphis, Ark. (234), on August 14 and tied up at the bank at Gayoso, Mo. (106), on August 17. The next day the steamer *Nokomis* went to the coal fleet at Cherokee (90) and returned with two barges of coal. The plant was then anchored in the crossing known as Hathaways (103) and dredging was commenced that night. As the river had commenced to rise, dredging was not seriously required, but as the plant had not before been assembled this season as a whole it was thought advisable to make a few cuts through the reef and test the plant. This work was finished at 7.30 a. m. August 20, and the plant swung out of the channel to await a lower stage of the

of floating pipe, left the fleet at West Memphis, Ark., and arrived at Peters Towhead Crossing (270) on the same day. The survey was finished and dredging commenced on the 20th. The work necessary was finished on the 23d, and the boat was tied up at the bank to await a lower stage of the river. On September 25 the dredge was moved to Polks Crossing (266), where it was thought the next dredging would be necessary. Dredging at Polks was commenced on October 5 and finished on October 12. A survey of Polks on October 14, two days after dredging, shows a 15½-foot channel 100 feet wide, a 13½-foot channel 150 feet wide, an 11½-foot channel 390 feet wide, and a 9½-foot channel 1,300 feet wide. The channel at Peters Towhead Crossing, a few days after dredging, is shown by survey to have had a narrow channel nearly across the reef 13 feet in depth. It also shows an 11-foot channel 900 feet wide and a 9-foot channel 1,200 feet wide.

On November 1 the boat was returned to Peters Towhead Crossing and dredging resumed that day. Work on the upper reef was finished on November 2, and the boat was moved down to the lower reef near the Lady Lee light and one cut made through this reef, and on November 4 the dredge was moved to what is known as Peters Upper Crossing (269), where dredging was commenced on that day and finished on November 6. Dredging at Peters Upper Crossing was again resumed on the 9th, work being delayed by repairs to machinery. It was finished, however, on November 12, and the dredge was moved to Star Crossing (260) that day. The work at Star Crossing was finished on November 16. It was found, however, that a lump had been formed by the discharge pipe in the lower part of the channel, and work was again resumed at 1.30 p. m. on the 17th and finished at 9 a. m. on the 18th, after which a survey was made. After completion of the survey, dredging was again resumed on the 19th on another lump which had been made still lower down. Work continued until 7 p. m. on the 20th, when it was found necessary to shut down and rebabbit the crank-pin brasses of the main starboard pumping engine. Work was resumed on November 25 and finished on the 26th, when the boat left Star Crossing to go into winter quarters at West Memphis, Ark. It arrived there on November 27. A large portion of the crew was discharged and the machinery laid up for the winter.

Survey of Star Crossing, after completion of the work, shows an 11-foot channel 200 feet wide and a 9-foot channel 600 feet wide. At Peters Upper Crossing there was an 11-foot channel 350 feet wide and a 9-foot channel 500 feet wide. At Peters Towhead Crossing there was a narrow ridge across the upper end of the channel over which there was only 11 feet for a distance of about 100 feet. There was, however, a 13-foot channel of considerable width through the remainder of the crossing and a 9-foot channel 600 feet wide through the entire crossing.

INSPECTION.

The steamer *Search*, with a double crew, was used as an inspection boat and for the transportation of supplies to the parties in the field. Twenty-three round trips of inspection were made over the shoal portion of the river. There was no shoal water during the season where the depth was less than 9 feet below Mhoons Crossing (275). Therefore none of the trips of inspection were made lower than this point, and but one above New Madrid, Mo. There is inclosed herewith table showing depths observed over all crossings.

During the low-water season there was a depth of 10 feet through all channels except as follows: There was 9½ feet at Hatchie Island from August 2 to 16, and 9½ feet at Presidents Island from August 9 to 11. It is noted also that the Cairo gauge read as low as 2.9 feet, the New Madrid gauge 3.4 feet, and the Memphis gauge — 0.3 foot. While the river was at this extreme low stage, about November 27, there was 10 feet depth of water over all shoal crossings.

I desire to call your attention to the success and cheapness of work of the self-propelling dredges *Iota*, *Kappa*, and *Henry Flad*, as no tender nor pile sinker is required, thus saving labor and fuel, and these plants can be moved from place to place in much less time and can be much more easily handled in cross currents than the other form of dredges.

DREDGE GAMMA.

On October 17, 1901, the dredge *Gamma* and its accompanying plant, in tow of the steamer *Choctaw*, left the fleet at West Memphis, Ark., for Lake Providence, La. (543), with instructions to report to the engineer officer in charge of the Third district. The boat arrived at Stack Island, near Lake Providence, on October 21, and dredging was commenced on October 23. The work at this place consisted in dredging through

the point of a sand bar which deflected the current of the river against the bank, which was caving in above the revetment near Lake Providence, La.

While the details of the work at this place are not known, the following data are given: Six cuts were made clear through the bar and 3 short cuts at the upper end; the total length of all cuts was 35,065 feet; the average depth of the cuts was 10.2 feet.

Dredging was discontinued on December 1, 1901, and as the work under the orders of the officer in charge of the Third district was finished an examination of the river was made on the steamer *Choctaw* by Mr. Gerig, assistant engineer in charge of the *Gamma*, as far as Vicksburg, Miss. At Youngs Point (595) the reconnaissance only gave 9 feet, but it was assumed that a survey would show more water than this, and the *Choctaw* returned to the *Gamma* at Lake Providence, and left that place on that day for the fleet at West Memphis, Ark., arriving there on December 19, where the crew was discharged except those necessary to care for the plant.

MAPS AND TABLES.

The following maps and tables have been transmitted to your office during the period of this report:

Maps of all shoal crossings, showing the condition of the channels and the location of dredge cuts wherever work was found necessary or thought to be necessary during the season.

Tables showing the time engaged at different kinds of work and the conditions under which the work was performed by the dredges.

Tables showing the least depths over all shoals below the mouth of the Ohio River at Cairo, Ill., during the low-water season of 1901.

Tables showing the cost of the care of plant and the cost of repairs to the different pieces of plant, as well as itemized cost of the field operations at the different bars.

Respectfully submitted.

C. W. STURTEVANT,

Assistant Engineer, Superintendent Dredging Operations.

Capt. G. P. HOWELL,

Corps of Engineers, U. S. Army,

Secretary Mississippi River Commission.

Sup. Eng.—02—6

TABLE No. 8.—Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1901.

BETA.

Points of operations.	Distribution of time.								Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working; awaiting lower stage, etc.								
	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Miles.		Fect.	Fect.	Fect.	Fect.	Pounds.	
Hatchie Island (181), first time.	17.00	143.35	11.05	30.00	.....	5.00	46.30	409.50	51	15	11,620	81.0	15	6.2	165	127
Aug. 4-31.....																
Hatchie Island (181), second time.	10.25	85.40	16.45	.....	.....	.....	.....	227.35	.....	14	10,550	121.9	18	4.0	171	182
Sept. 1-15.....																
Hatchie River (180), first time.	2.00	142.45	14.05	3.25	.....	1.35	.45	215.00	1	16	11,725	82.1	18	5.3	175	133
Sept. 15-30.....																
Hatchie River (180), second time.	4.45	65.15	8.45	.....	.....	.....	.....	126.30	.....	9	6,975	107.0	17	3.8	174	133
Oct. 1-9.....																
Hatchie Island (181), third time.	3.35	72.10	9.00	1.00	.....	3.15	1.00	448.45	1	10	7,625	106.0	16	4.6	174	133
Oct. 9-31.....																
Hatchie River (180), third time.	5.30	94.40	7.25	.25	.....	1.00	16.00	121.00	1	10	7,985	84.0	14	3.8	174	132
Nov. 1-11.....	10.30	55.50	2.45	5.25	.....	4.00	9.15	224.15	2	7	5,080	91.0	14	4.6	174	132
Morgans Point (182), Nov. 11-24.....																
Moving into winter quarters, Nov. 24-25.....									50							
Total and average.....	53.45	659.55	69.50	49.15	.....	19.50	110.30	1,772.55	106	81	61,560	93.0	.....	4.7	.....	.....

a Includes 14½ hours after arrival at fleet.

EPSILON.

Hathaway (103), first time, Aug. 14-31.....	26.00	4.15	0.45	17.00	14.30	83.00	286.30	432.00	129	2	1,100	258.8	16	1.9	136	175
Hathaway (103), second time, Sept. 1-15.....	1.40	43.40	13.20	26.05	.....	.....	.....	360.00	.....	11	8,375	191.6	17	3.7	130	176
Reelfoot (99), first time, Sept. 16-30.....	4.15	63.25	27.45	2.20	4.10	1.55	275.00	360.00	4	16	12,735	201.0	17	3.4	129	176
Reelfoot (99), second time, Oct. 1-31.....	4.30	140.30	25.20	1.50	.....	.....	567.00	744.00	.....	25	20,665	147.0	17	4.4	127	176
Reelfoot (99), third time, Nov. 1-15.....	3.40	73.20	19.40	82.50	4.40	2.25	156.25	333.00	.....	15	12,000	159.0	15	5.2	125	176
Joe Eckles (96), Nov. 15-18.....	3.15	39.20	22.45	.....	3.25	3.00	.....	72.00	6	13	10,675	271.0	14	4.1	120	175
Reelfoot (99), fourth time, Nov. 18-Dec. 5.....	9.35	74.40	19.40	.....	7.40	3.55	294.30	410.00	6	21	15,265	204.0	13	3.4	123	174
Moving into winter quarters, Dec. 5-9.....	.....	.....	.....	.....	2.40	640.20	.....	43.00	133	.....	.....	.....	.....	.....	.....	.....
Total and average.....	52.55	441.10	133.15	130.20	33.05	132.50	1,836.25	2,760.00	278	103	80,845	133.2	.....	4.0	.....	.....

ZETA.

Plum Point (163), first time, Aug. 9-31.....	4.00	88.56	17.20	14.04	7.35	28.30	391.35	552.00	69	23	16,775	189.0	16	4.2	137	165
Plum Point (163), second time, Sept. 1-30.....	5.20	48.25	19.20	2.35	2.30	30	641.20	720.00	.....	14	10,725	221.6	16	4.0	136	165
Plum Point (163), third time, Oct. 1-12 and 31.....	1.30	88.13	22.25	16.07	1.45	5.00	155.00	290.00	.....	26	18,865	214.0	16	3.9	134	173
O'Donnells (149), Oct. 12-31.....	3.20	34.33	11.56	.....	2.50	6.00	395.21	454.00	14	18	13,775	398.0	16	2.1	133	174
Gold Dust (168), Nov. 1-12.....	3.45	85.58	18.20	4.16	3.00	7.35	162.16	285.10	9	32	23,555	274.0	15	3.5	131	175
Last Chance (166), Nov. 12-20.....	3.15	53.05	7.56	3.25	5.55	5.20	105.39	184.35	8	17	11,325	213.0	15	3.6	130	176
Moving into winter quarters, Nov. 20-21.....	.....	.....	.....	.....	1.00	533.15	.....	34.15	66	.....	.....	.....	.....	.....	.....	.....
Total and average.....	21.10	399.10	97.17	40.27	24.35	86.10	1,851.11	2,520.00	166	130	95,050	238.1	.....	3.6	.....	.....

a Includes 10 hours at bank assembling pontoons.

b Includes 64 hours after arrival at fleet.

c Includes 8 hours after arrival at fleet.

TABLE NO. 8.—Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1901—Continued.

IOTA.

Points of operations.	Distribution of time.								Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working: awaiting lower stage, etc.	Total.							
	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Hours.	Miles.	Fect.	Fect.	Fect.	Fect.	Pounds.	154
Booths Point (119), first time, Aug. 7-31	11.30	17.10	66.30	160.20	.....	14.00	93.30	297.00	600.00	113	1,200	70.0	16	7.2	148	154
Booths Point (119), second time, Sept. 1-30	6.45	97.10	39.35	52.10	.....	1.20	3.20	519.40	720.00	.....	27,875	287.0	16	2.6	138	158
Booths Point (119), third time, Oct. 1-13	7.00	98.08	16.17	21.15	.....	6.00	1.35	147.50	293.05	.....	21,600	232.0	15	2.9	145	160
Hathaway (103), third time, Oct. 13-31	5.20	51.54	16.41	10.25	.....	5.10	14.15	347.10	450.55	16	9,300	179.0	15	3.0	144	160
Hathaway (103), fourth time, Nov. 1-10	2.30	35.45	8.20	6.55	.....	.....	1.00	178.00	227.30	.....	7,250	203.0	13	2.9	151	160
Miss Hickmans (131), Nov. 10-19	2.10	28.43	2.15	11.35	.....	3.15	22.35	150.05	220.40	27	6,100	212.0	13	2.4	151	160
Plum Point (163), fourth time, Nov. 19-24	2.45	26.10	5.25	7.05	.....	.....	21.35	52.00	115.00	33	7,000	267.0	14	2.8	144	160
Hatchie Island (181), fourth time, Nov. 24-Dec. 4	2.15	59.30	16.15	4.40	.....	.30	7.15	146.55	237.20	18	13,500	227.0	14	3.2	139	159
Moving into winter quarters Dec. 4	.....	.....	.....	.....	.....	1.30	14.00	.....	15.30	51	.....	.....	.....	.....	.....	.....
Total and average.....	40.15	409.32	106.18	274.25	.....	31.45	179.05	1,838.40	2,880.00	258	105,825	229.1	.....	2.9	.....	.....

a Includes sinking experimental anchors.

KAPPA.

Presidents Island (234), first time, Aug. 12-31.....	51.30	95.00	8.45	34.00	.....	1.15	3.00	286.30	480.00	2	9	8,000	84.2	16	3.1	6150	6130
Presidents Island (234), second time, Sept. 1-30.....	1.30	140.05	23.00	22.40	.....	2.00	1.30	529.15	720.00	.....	27	22,150	158.1	17	3.2	151	129
Presidents Island (234), third time, Oct. 1-30.....	.15	188.30	8.45	56.45	1.00	.....	.30	488.15	744.00	.....	20	19,175	102.0	17	4.6	149	130
Graves Bayou (260), Nov. 1-12.....	.15	42.15	3.00	3.30	.....	.....	4.15	218.45	274.00	16	8	7,850	186.0	17	4.7	148	130
Presidents Island (234), fourth time, Nov. 12-30.....	1.45	75.00	6.45	2.45	.30	.....	12.30	346.45	446.00	16	10	9,100	121.0	16	4.8	149	129
Total and average.....	55.15	540.50	50.15	121.40	1.30	3.15	21.45	1,869.30	2,664.00	34	74	66,275	122.5	.....	4.0	.....	.....

HENRY FLAD.

Peters Towhead (270), first time, Sept. 19-24.....	1.30	60.31	12.09	3.50	.....	(c)	5.35	60.25	144.00	38	19	12,600	208.2	17	3.1	138	129
Polks (266), Sept. 25-30.....	.55	127.31	17.53	25.36	.....	.....	3.55	140.05	144.00	4	23	17,575	138.0	19	4.5	132	129
Peters Towhead (270), second time, Oct. 1-31.....	1.40	37.50	3.05	10.40	.....	.....	3.10	22.35	79.00	4	5	5,680	150.0	16	4.7	142	128
Nov. 1-4.....	2.14	55.18	7.03	50.05	.....	.....	1.30	76.20	192.30	1	10	10,100	183.0	15	4.3	143	130
Peters Upper (269), Nov. 4-12.....	.45	110.50	15.30	100.25	.....	.....	6.00	101.30	335.00	9	16	17,660	159.0	14	4.3	141	129
Star Landing (260), Nov. 12-26.....	.....	.....	.....	.....	.....	.....	d 41.30	.....	41.30	28	.....	.....	.....	.....	.....	.....	.....
Moving into winter quarters, Nov. 26-27.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total and average.....	7.04	392.00	55.40	191.36	.....	.....	61.40	972.00	1,680.00	84	73	63,615	162.3	.....	4.2	.....	.....

GAMMA.

Stack Island bar (541), Oct. 17-Dec. 3, Moving into winter quarters, Dec. 4-19.....	63.45	786.15	125.00	33.25	.....	.....	97.30	108.06	1,164.00	309	.....	35,065	47.4	20	9.8	135	166
Total and average.....	63.45	786.15	125.00	33.25	.....	.....	3.30	368.30	372.00	309	.....	35,065	47.4	.....	9.8	.....	.....

^a Sinking experimental anchors.^b Average for 2 days' dredging.^c The work of this dredge at Stack Island was under the direction of the third district officer and in connection with maintenance of revetment work at Lake Providence.^d Making up tow for this dredge included in time not working.^e Includes 164 hours after arrival at fleet.

TABLE NO. 9.—Cost of dredging operations, April 1, 1901, to March 31, 1902.

	Labor.	Office supplies.	Substenance.	Fuel.	Lighting supplies.	Lubricants.	Repairs.	Permanent outfit.	Contract work.	Total.	Grand Total.
Care of plant.....	\$26,220.90	\$208.90	\$5,654.01	\$5,785.06	\$111.17	\$137.99	\$917.56				\$39,085.59
Repairs to plant:											
Dredge Beta.....	1,312.61		234.58	123.40	1.06		1,373.89			\$3,045.54	
Dredge Gamma.....	1,765.82		274.65	97.68	1.60	.10	651.86			2,692.06	
Dredge Delta.....	3,157.30	.37	511.04	74.22	6.95	3.99	8,304.51			12,068.01	
Dredge Epsilon.....	2,045.87		319.62		10.46	2.68	510.21			2,868.74	
Dredge Zeta.....	1,866.46		300.80		5.50		470.53			2,643.29	
Dredge Iota.....	1,970.02		289.68		.25	1.40	463.34			2,724.69	
Dredge Iota's pontoons.	932.35		133.99		.70	1.73	2,522.88			3,691.65	
Dredge Kappa.....	87.03		17.21				147.94			252.18	
Dredge Henry Flad	382.01		66.96		.19		146.10			665.26	
Steamer Sachem.....	186.41		39.65				60.12			286.18	
Steamer Choctaw.....	427.61		75.81		.09		79.11			562.62	
Steamer Nokomis.....	138.11		18.13				44.29			200.53	
Steamer Wynoka.....	600.49		71.86				197.77			770.12	
Steamer Leota.....	169.69		27.20		.10		119.39			306.38	
Steamer Minnetonka.....	46.23		5.54		.02		8.45			60.24	
Steamer Search.....	654.97		96.37		9.14	.70	1,340.02			2,100.60	
Steamer Vulcan.....	352.28		59.76		.40		78.13			491.26	
Steamer Venus.....	239.59		40.41		1.16		122.23			402.49	
Steamer Mars.....	85.08		15.71		1.16		28.41			130.36	
Steamer Mercury.....	283.91		60.60		.24	2.40	63.14			370.69	
Pile sinkers.....	139.99		18.71				26.19			184.89	
Barges, quarterboats, flats, and skiffs.	646.66		97.80				169.97			874.43	
Total.....	17,320.49	.37	2,755.97	235.30	37.86	13.66	16,946.67			37,370.32	37,370.32
New plant: Pipe lines for dredges Kappa and Henry Flad.....	410.85		56.15	301.70	10					24,397.40	24,397.40
Testing dredges Kappa and Henry Flad.....	3,232.92	2.70	700.15	432.00	8.74	16.45	176.46		\$23,628.50	4,569.42	4,569.42
Operations during low-water season, 1901:											
Dredge Beta.....	12,313.65	13.08	2,837.71	7,444.57	50.87	209.44	972.19			23,841.51	
Dredge Gamma.....	6,376.60	10.41	1,439.29	3,076.68	38.03	161.14	1,234.98			12,357.63	
Dredge Epsilon.....	10,312.01	8.20	2,268.51	6,894.91	68.26	216.94	644.80			19,373.23	
Dredge Zeta.....	3,325.20	13.41	1,842.76	3,894.61	59.32	199.46	809.20			16,108.95	
Dredge Iota.....	5,441.11	11.16	1,925.05	3,919.72	39.24	367.46	949.45			15,633.19	
Dredge Kappa.....	1,122.08	12.21	1,601.06	4,394.11	40.24	149.23	1,064.46			14,223.38	
Dredge Henry Flad.....	5,563.08	13.12	1,366.35	3,063.94	28.72	115.39	946.66			10,506.26	
Steamer Vulcan.....	31.86		47.72	383.96	3.80	13.31	46.90			3,268.65	
Steamer Venus.....	2,576.99	39.51	435.86	526.12	17.87	14.08	65.43			3,725.81	

Steamer Mars.....	1,406.67	20.35	255.92	311.45	5.51	6.18	20.21	.....	2,026.29
Steamer Search.....	5,165.27	43.45	1,102.38	2,037.50	87.27	40.83	109.67	.....	8,530.32
Total	70,998.74	216.76	15,471.65	34,787.59	384.63	1,493.40	6,263.45	.....	129,616.22
Tools, appliances, and outfit.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	118,183.90	423.73	24,637.93	41,601.65	542.50	1,661.50	24,432.83	.....	237,414.72

TABLE No. 10.—*Depths over shoal crossings, Mississippi River, low-water season of 1901.*

Miles below Cairo.		Name of bar.	Dates of trips, 1901.																												
			Aug. 2-4.	Aug. 9-11.	Aug. 14-16.	Aug. 17-20.	Sept. 8-8.	Sept. 9-12.	Sept. 12-17.	Sept. 20-23.	Oct. 4-7.	Oct. 9-11.	Oct. 11-14.	Oct. 20-23.	Oct. 26-30.	Nov. 2-10.	Nov. 11-16.	Nov. 18-20.	Nov. 21-27.	Nov. 30-Dec. 5.											
0	{	<i>Fed.</i>	9.7	<i>Fed.</i>	7.9	<i>Fed.</i>	10.4	<i>Fed.</i>	12.7	<i>Fed.</i>	12.0	<i>Fed.</i>	11.7	<i>Fed.</i>	8.8	<i>Fed.</i>	6.4	<i>Fed.</i>	6.3	<i>Fed.</i>	5.4	<i>Fed.</i>	4.3	<i>Fed.</i>	3.2	<i>Fed.</i>	3.1	<i>Fed.</i>	2.9	<i>Fe et al.</i>	3.1
		9.4	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	2.9	3.8
29																	14														
55		Medleys.....															13														
69		Donaldsons Point.....																													
		Kentucky Point.....																													
70		New Madrid Gauge.....	{	9.1	7.8	7.0	8.9	11.2	10.4	9.6	11.8	9.4	8.3	6.0	7.2	5.8	4.8	3.7	3.6	3.5	3.4	3.4	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.9
			{	8.8	7.1	8.5	14.0	10.5	9.6	8.1																					
71		New Madrid.....												14																	
74		Watsons.....		14					16					15																	
76		Nolans.....		14					15					13																	
79		Upper Point Pleasant.....		15			17.5		16					13																	
81		Point Pleasant.....		15			19		17					13																	
83		Bixbys Towhead (or Gervins).....		16					17					16																	
90		Cherokee.....		16			12.5		14.5					12																	
93		Little Cypress Bend (Joe Eckles).....		12			14.5		16					13																	
95		Mrs. Basses.....		17			13.6		16					14																	
99		Reelfoot.....		12			16		14.5					13																	
103		Hathaways.....		11			16		14.6					16																	
119		Booths Point or Island 18.....		10			12		15					14																	
126		Tylers.....		13.5			16.5							17																	
131		Miss Hickmans.....		13.5			11							15																	
145		Wardlown Pocket.....		16.5			14.5							15																	
149		O'Donnells.....		16.5			14							15																	
158		Gold Dust.....		15.5			12							14																	

TABLE No. 10.—*Depths over shoal crossings, Mississippi River, low-water season of 1901—Continued.*

Name of bar.	Miles below Cairo.	Dates of trips, 1901.																																			
		Aug. 2-4.		Aug. 9-11.		Aug. 14-16.		Aug. 17-20.		Sept. 6-8.		Sept. 9-12.		Sept. 12-17.		Sept. 20-22.		Oct. 4-7.		Oct. 9-11.		Oct. 11-14.		Oct. 20-22.		Oct. 26-30.		Nov. 2-10.		Nov. 11-15.		Nov. 16-20.		Nov. 21-27.		Nov. 30-Dec. 5.	
		Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.	Feet.	Pct.		
Luxora.....	161	15	12	12	13	18	14.5	13	12	13	11.5	14	16	16	16	16	16	16	16	13	12	13	11.5	14	13	12	13	11.5	14	12	13	11.5	14	12.5	13	11.5	14
Plum Point (or Foot Island 30).....	183	11	12	11	15	15	15	15	15	15	15	15	15.5	15	15.5	15	15	15	15	15	15	15	15.5	14	13	12	13	11.5	14	12	13	11.5	14	12.5	13	11.5	14
Last Chance.....	166	13	11.5	13.5	16	16.5	16	16.5	16	16.5	16	16	16	16	16	16	16	16	16	13	12	13	11.5	14	13	12	13	11.5	14	12	13	11.5	14	12.5	13	11.5	14
Below Fulton Bluff.....	176																																				
Hatchie River.....	180																																				
Hatchie Island (or Mill Point).....	181	9.5		9.5	12	14	12	14	15	16	16	16	16	16	16	16	16	16	16	13	12	13	11.5	14	13	12	13	11.5	14	12	13	11.5	14	12.5	13	11.5	14
Morgan's Point.....	182																																				
Random Shot.....	192	13.5	16.5																																		
Pecan Point.....	196	18																																			
Old Hen.....	226	18																																			
Memphis gauge.....	230	5.4 to 4.8	4.3 3.6	3.0 3.3	4.0 6.1	8.6 6.8	6.5 5.6	5.6 4.5	4.5 6.4	4.8 3.3	2.8 2.3	2.4 2.4	2.4 2.4	2.4 2.4	2.4 2.4	2.4 2.4	2.4 2.4	2.4 2.4	2.4 2.4	2.8 2.3	2.4 2.4	2.4 2.4	2.4 2.4	2.2 1.9	1.9 1.4	1.1 0.3	0.3 0.1	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	0.1 0.0	
Presidents Island.....	234		9.5	10	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	
Fleecem.....	243																																				
Graves Bayou.....	250																																				
Cat Island.....	253																																				
Sar Landing.....	260																																				
Polks.....	267																																				
Upper Peters.....	269																																				
Peters.....	270																																				

NOTE.—An examination of the river between Vicksburg, Miss. (600), and West Memphis, Ark. (232), made on the steamer *Chodan* December 1-19, showed not less than 9 feet of water on any crossing.

APPENDIX 1 D.

REPORT OF ASSISTANT ENGINEER F. B. MALTBY ON CARE AND REPAIR OF DREDGING PLANT SINCE JANUARY 1, 1902.

UNITED STATES DREDGE FLEET,
West Memphis, Ark., May 1, 1902.

CAPTAIN: I have the honor to submit the following report pertaining to dredges and dredging for the period January 1, 1902, to March 31, 1902:

This report is made as a supplement to the report of Assistant Engineer C. W. Sturtevant for the period April 1, 1901, to December 31, 1901, and reference is made thereto.

On January 1, 1902, all the plant mentioned in Mr. Sturtevant's report was assembled and being cared for at West Memphis, Ark., except the steamer *Patrol*, which was returned to the fleet on January 6. The *Patrol* again left the fleet on January 15 for Cairo, where it was expected that new pontons for the *Kappa* and *Henry Flad* would be received. The pontons not having arrived, the *Patrol* went to the Tennessee and Cumberland rivers for the purpose of laying out high-water discharge sections. It returned to the fleet on January 27. On February 3 this boat left the fleet for Cairo and returned on the 9th with the new pontons in tow.

The steamer *Mississippi* left the fleet March 24 for St. Louis to make the semiannual Commission inspection trip, and on March 31 was at St. Louis, Mo.

With the exception of the steamers *Fulcan* and *Mars*, which have been used as fleet tenders, no other boats have been in commission.

CARE OF PLANT.

The fleet has been cared for in the usual manner. Labor has been expended in sparring out, hauling in lines, cleaning the inside of hulls, coaling boats on which steam is carried, laying up machinery, checking, assorting, and cleaning property, subsisting employees, and general office work. During the period 9,592 rations have been served, at a cost of \$2,664.83 for supplies and \$1,053.75 for services; total, \$3,718.58, or \$0.3876 per ration, including cost of quarters and office.

REPAIRS TO PLANT.

Dredge Beta.—The main-pump casings were bored out. This was accomplished with the pumps in place by means of attaching tools to the runner blades and turning the shaft by means of a rope drive from the electric-light engine. The crosshead pins of the main engines were turned up and main journals and crossheads rebabbitted. Minor repairs to valves and feed pumps have been made.

Dredge Gamma.—A new bearing for the jet pump was made. A steam heating system to replace stoves was installed and minor repairs made to valves and furnaces.

Dredge Delta.—The new suction head was received, placed in position, and riveted up. The new jet pumps have been placed in position and water connections made. The outside of the hull above the water line has been sand-blasted and painted, and the same work is being done below the water line to the knuckle by means of a small side dock about 30 feet long.

Dredge Epsilon.—Some extensive repairs to the main pump, contemplating the renewal of the side plates on the runner and some parts of the hub of the runner, are well under way. The boilers have been stripped and cleaned, and the work of putting in four new sheets by contract is well under way. The exhaust pipes from the main engines have been taken down and riveted. The cabin floor has been braced up.

Dredge Zeta.—The exhaust pipes from the main engines have been taken down and riveted. Minor repairs have been made to the feed pumps and the cabin floor braced up.

Dredge Iota.—The broken casting in the suction pipe from the main pump, on the port side, has been removed and a new one put in place. Extensive alterations to the suction head are under way and minor repairs to valves and piping have been made.

Dredge Kappa.—A sheet-iron jacket over the boiler breeching and around the stacks below the boiler deck has been made. Minor repairs have been made to valves and piping.

Dredge Henry Flad.—The exhaust pipes from the propelling engines have been taken down and riveted. Extensive alterations to the suction head are under way.

Steamer Wymoku.—The old piping has been taken down and useless wreckage removed. New nosing has been put in place and the wheel taken down.

Steamer Choctaw.—Minor repairs to steam joints have been made, the engines lined up, and the furnaces are being rebuilt.

Steamer Sachem.—Only minor repairs to pipes and pumps have been made.

Steamer Leota.—The engines have been lined up.

Steamer Nokomis.—Only minor repairs to valves and pipes have been made.

Steamer Vulcan.—New outriggers, nosing, plank-sheer, chocks, and deck forward of the cabin doors have been put on. The engines have been overhauled.

Steamer Venus.—A new canvas roof has been put on and minor repairs have been made to pump.

Steamer Mercury.—The boiler has been turned around and repairs are being made to bulkheads.

Steamer Patrol (S. G. & O.).—Repairs have been made to nosing and wheel. New packing rings have been made for the main engines, a steam heating system installed, new grate bars and fire-door liners put in place, and the roof and stacks painted.

Steamer Mississippi (M. R. C.).—The radiators in the forward cabin were changed to stand against the side bulkheads. Light blinds over staterooms were made and hung. A new outside entrance to closets was made, the boiler deck shored up and iron-pipe stanchions placed under same, the roof repaired and painted, the wheel repaired, the electric-light system overhauled, and miscellaneous work done in ship-ping up and preparing for the inspection trip.

Sunk Deck Flat.—New rakes were put on and the sides sheathed with 2-inch cypress and calked. The deck has been raised flush with the top of gunwales.

New Plant.—The new discharge pipe and pontons for the *Kappa* and *Henry Flad* have been received and the work of placing carriages on the same has been completed.

Respectfully submitted.

F. B. MALTBY,

Assistant Engineer, Superintendent Dredging Operations.

Capt. G. P. HOWELL,

Corps of Engineers, U. S. Army,

Secretary Mississippi River Commission.

APPENDIX 2.

REPORT OF CAPT. E. EVELETH WINSLOW, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,

Memphis, Tenn., May 20, 1902.

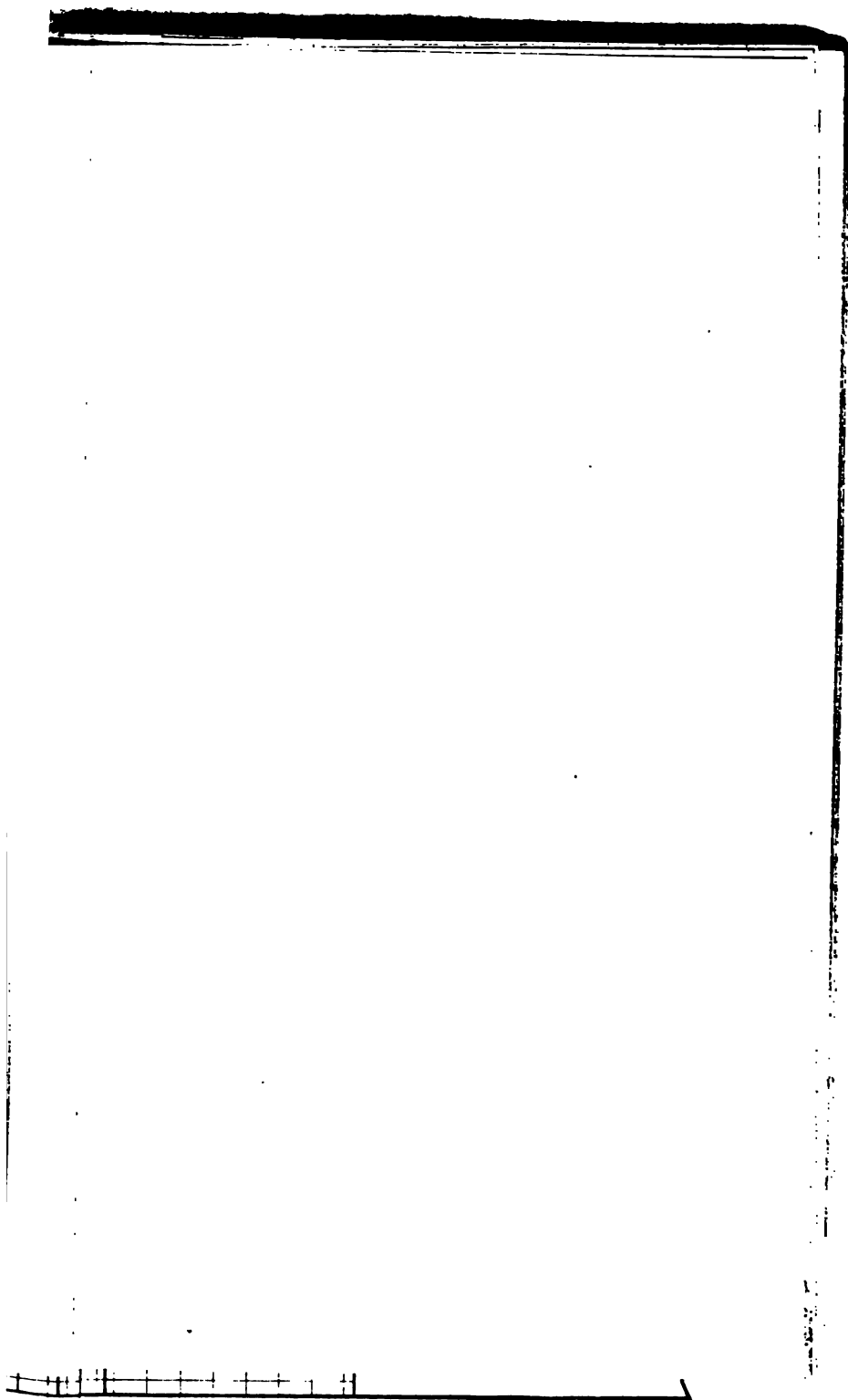
COLONEL: I have the honor to submit the following report of operations in the First and Second districts, Improving Mississippi River, for the year ending April 30, 1902.

The First district extends from Cairo, Ill., to the foot of Island No. 40, a distance of 220 miles. It includes the bank revetment work at Columbus and Hickman, Ky., and at New Madrid and Caruthersville, Mo.; the systematic improvement of Plum Point reach, Tennessee and Arkansas; certain experimental dike work; the Upper St. Francis levee district; the Reelfoot levee district, and part of the Lower St. Francis levee district from its initial point to the one hundred and thirty-ninth mile-post.

The Second district extends from the foot of Island No. 40 to the mouth of White River, a distance of 175 miles, but for convenience the limit of jurisdiction over the levees on the left bank has been placed at the Coahoma-Bolivar County line (365 L.), the levee on the left bank below that county line belonging to the Third district. Within the Second district are included the bank revetment work at Memphis, Tenn., and Hopefield Bend and Helena, Ark.; the improvement of Wolf River, Tennessee; the White River and Upper Yazoo levee districts, and the lower part of the Lower St. Francis levee district.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND NO. 40, 220 MILES).

Columbus, Ky. (21 miles below Cairo, L.).—In 1889 and 1890 some revetment work was done here with funds provided by special appropriations. The object of the work was to stop the caving of the river bank along the city front. The project for the work contemplated the construction of five spur dikes resting on sill mattresses. Dikes 1, 2, 4, and 5 were completed and the sill mattress of dike 3, work being





.

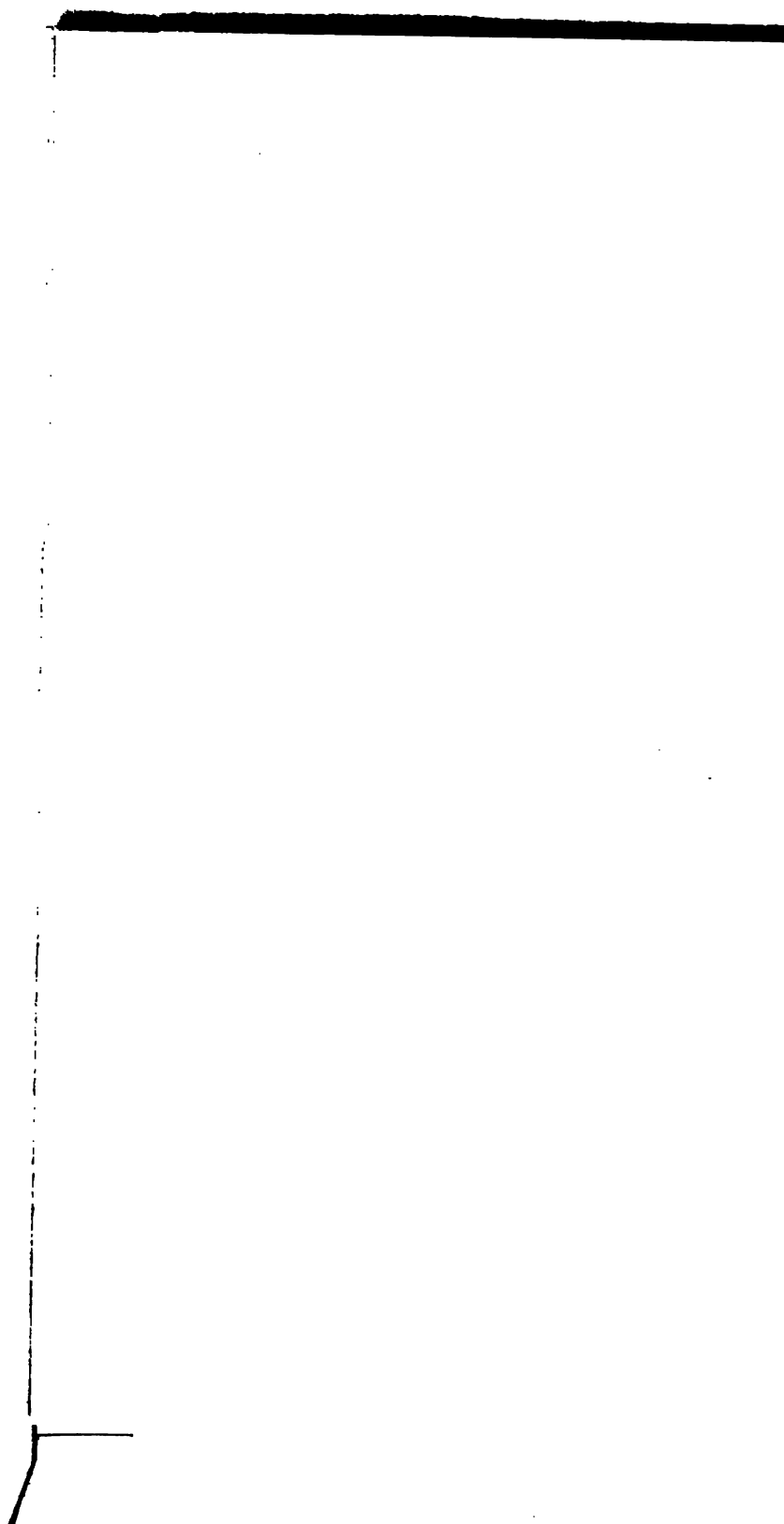




PLATE 9.

NEW AUTOMATIC TIDE GAGE AT BILLOXT, MISS.

To accompany my Annual Report for 1902.

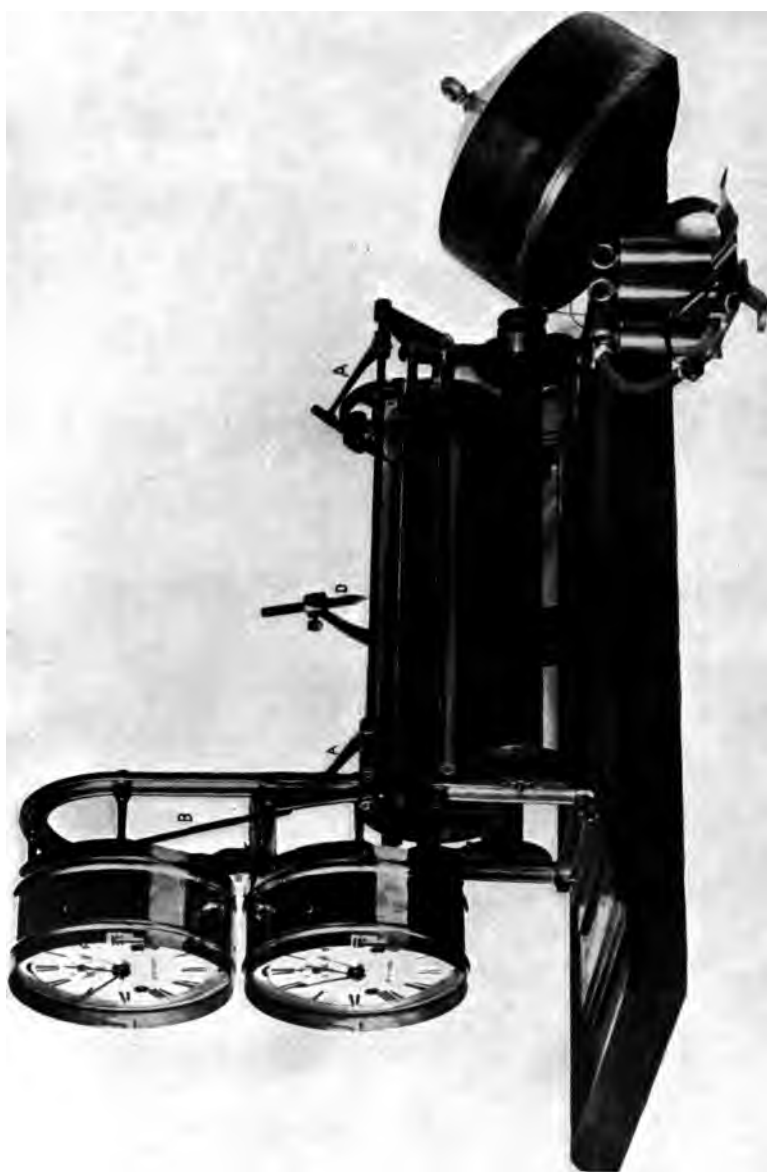
G. P. Howell

Captain, Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.



WORK

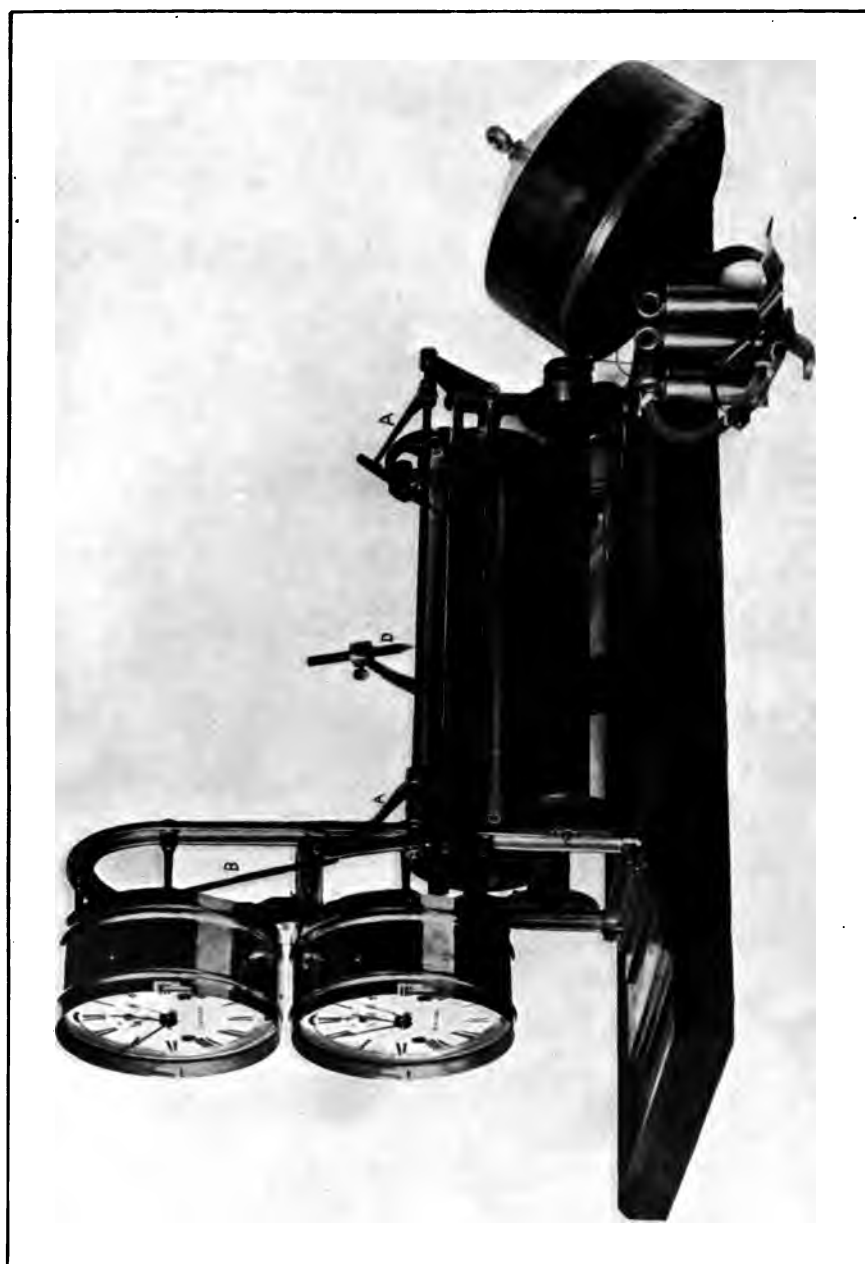
450



LOWER PART OF PLATE 3.

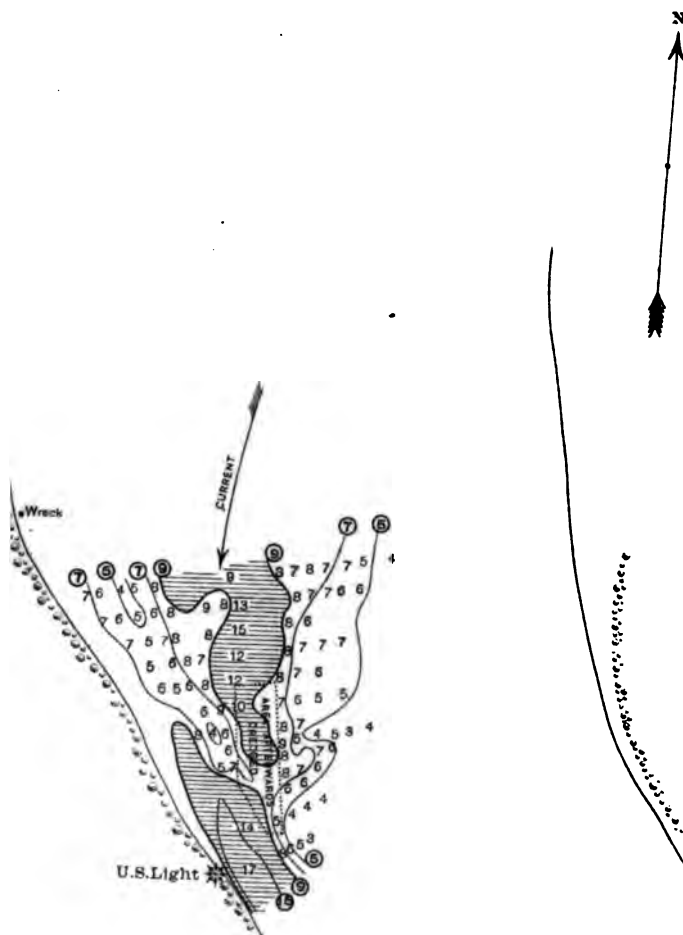
don't

8901



1901

PLATE 4.



MISSISSIPPI RIVER COMMISSION.

MAP OF

JOE ECKLES CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 8, 1901.

SEVEN DAYS BEFORE DREDGING.

SCALE OF FEET.



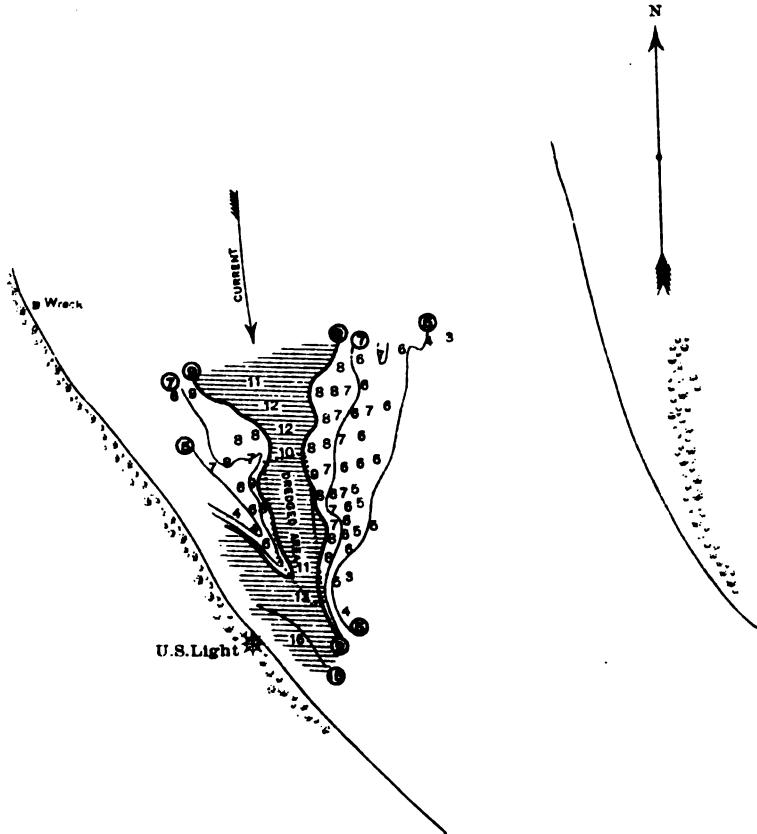
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.6 feet or 1.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

Ring 57 2

PLATE 5.



MISSISSIPPI RIVER COMMISSION.

MAP OF

JOE ECKLES CROSSING,

Made under direction of

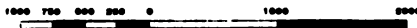
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 22, 1901.

FIVE DAYS AFTER DREDGING.

SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

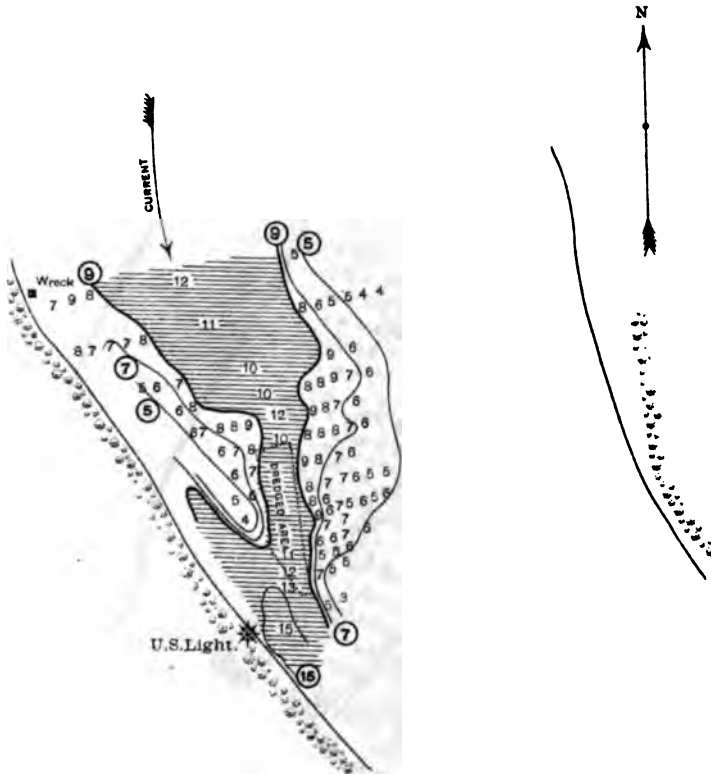
Gage at time of survey was 2.9 feet or 0.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2

1

PLATE 6.



MISSISSIPPI RIVER COMMISSION.
 MAP OF
JOE ECKLES CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of November 27, 1901.
 TEN DAYS AFTER DREDGING.
 SCALE OF FEET.

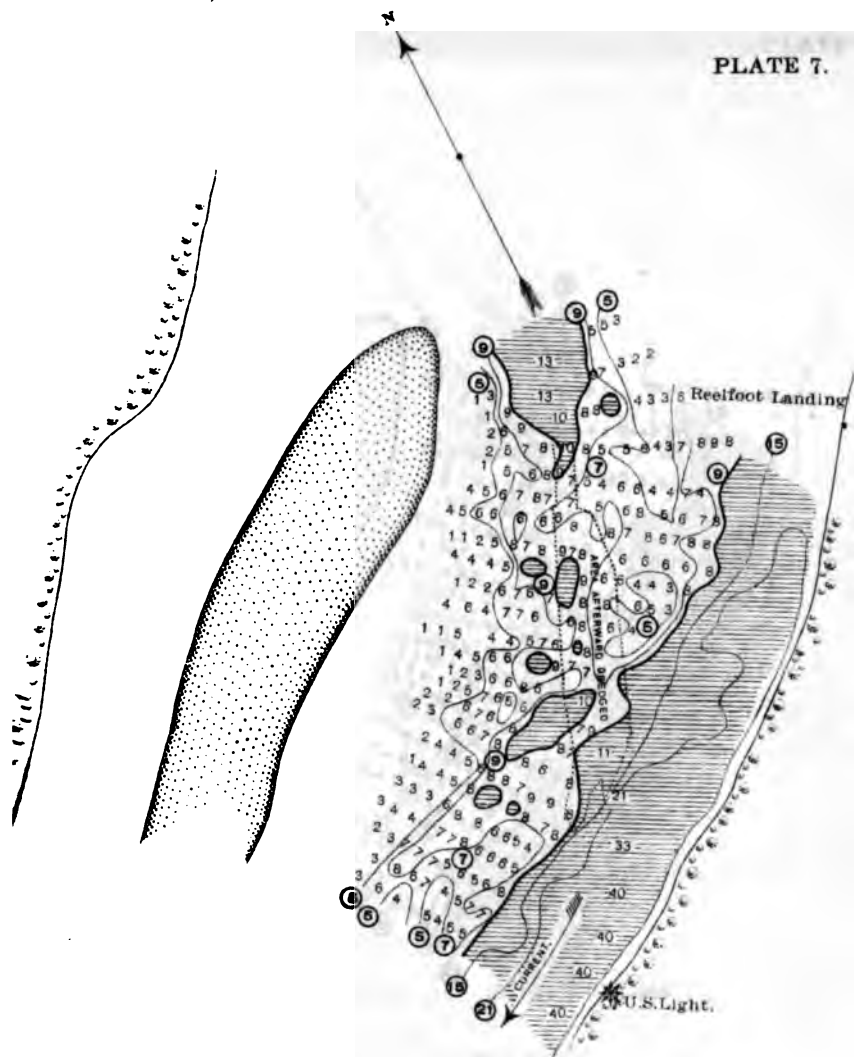


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.9 feet or 0.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

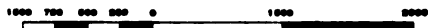
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 13, 1901.

THREE DAYS BEFORE DREDGING—FIRST TIME.

SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 3.3 feet.

Gage at time of survey was 9.3 feet or 7.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 21, 1901.

ONE DAY AFTER DREDGING—FIRST TIME.

SCALE OF FEET.

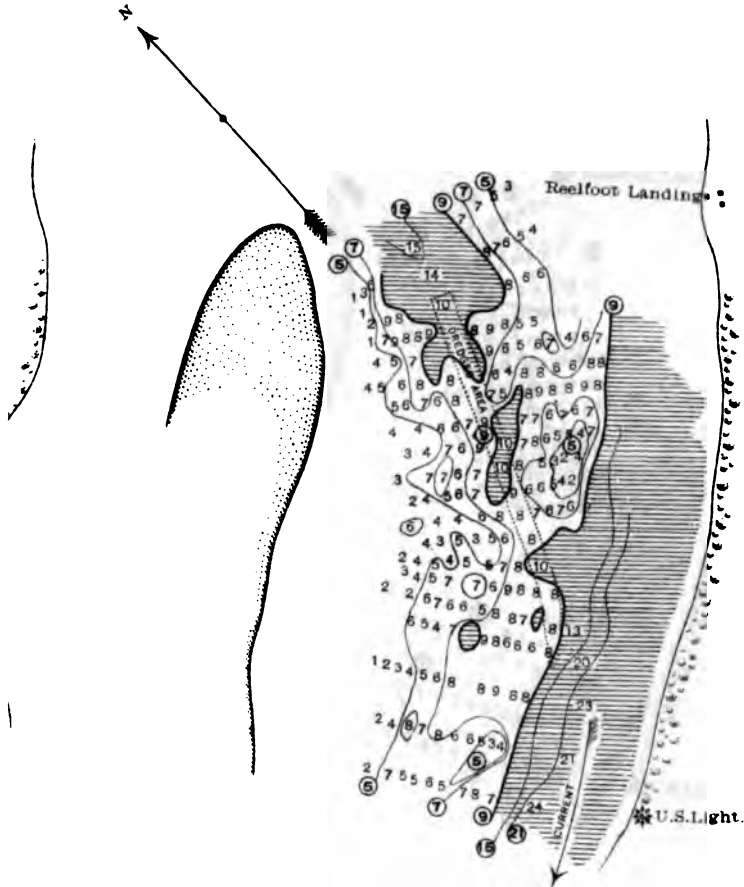


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.3 feet.

Gage at time of survey was 9.7 feet or 7.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

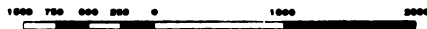
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 1, 1901.

SIX DAY BEFORE DREDGING—SECOND TIME.

SCALE OF FEET.

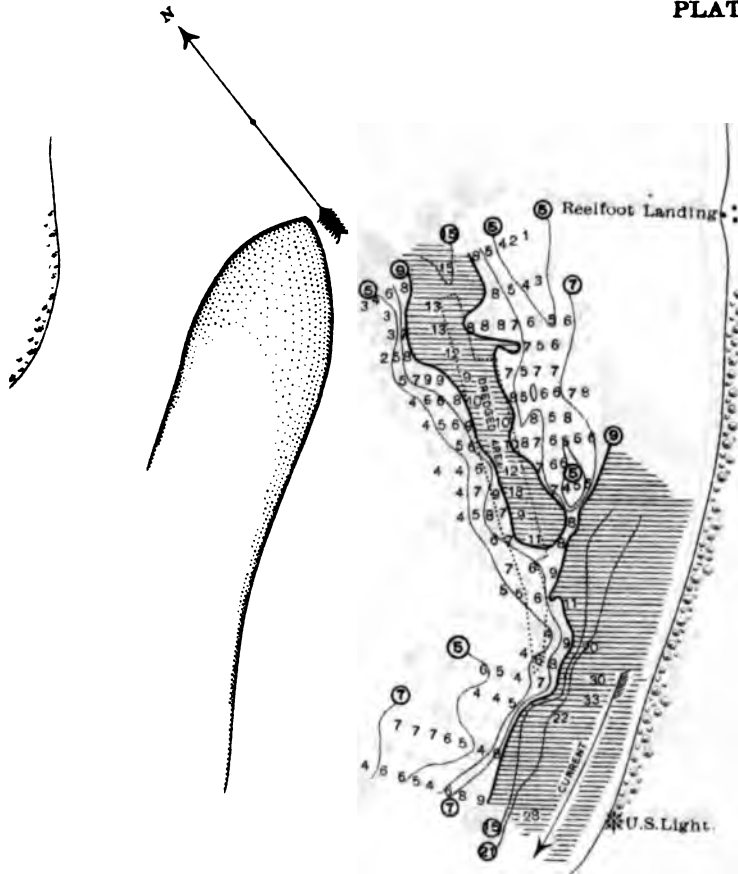


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 9.5 feet or 7.3 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2

1



MISSISSIPPI RIVER COMMISSION.
 MAP OF
REELFOOT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 17, 1901.
 TWO DAYS AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.

1000 700 500 200 0 1000 2000

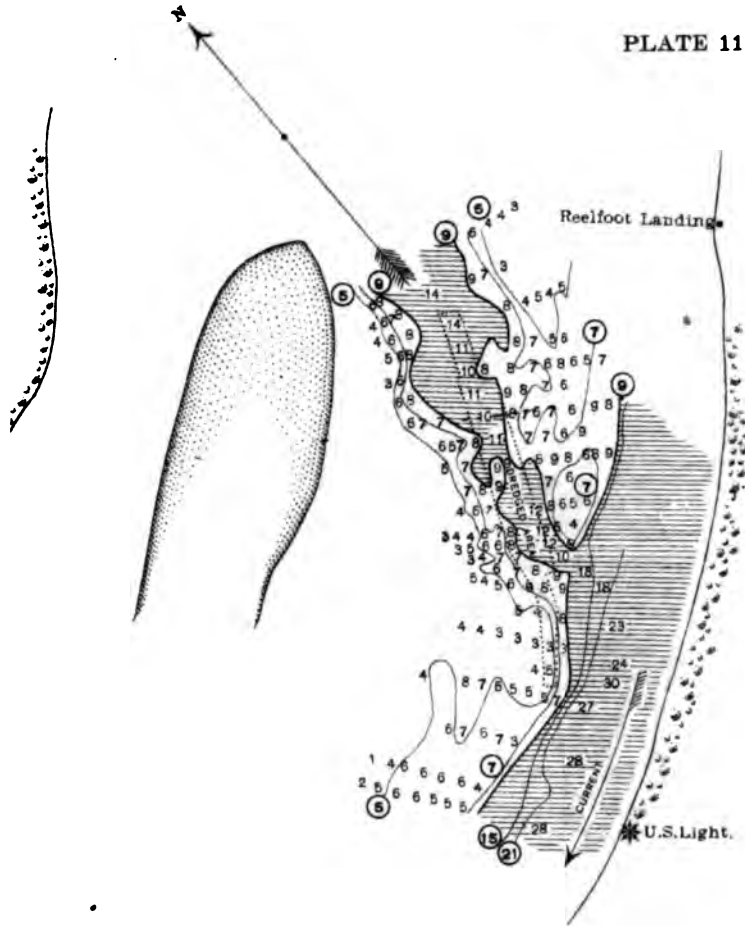
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 6.3 feet or 4.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2





MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary

Survey of October 22, 1901.

SEVEN DAYS AFTER DREDGING—SECOND TIME.

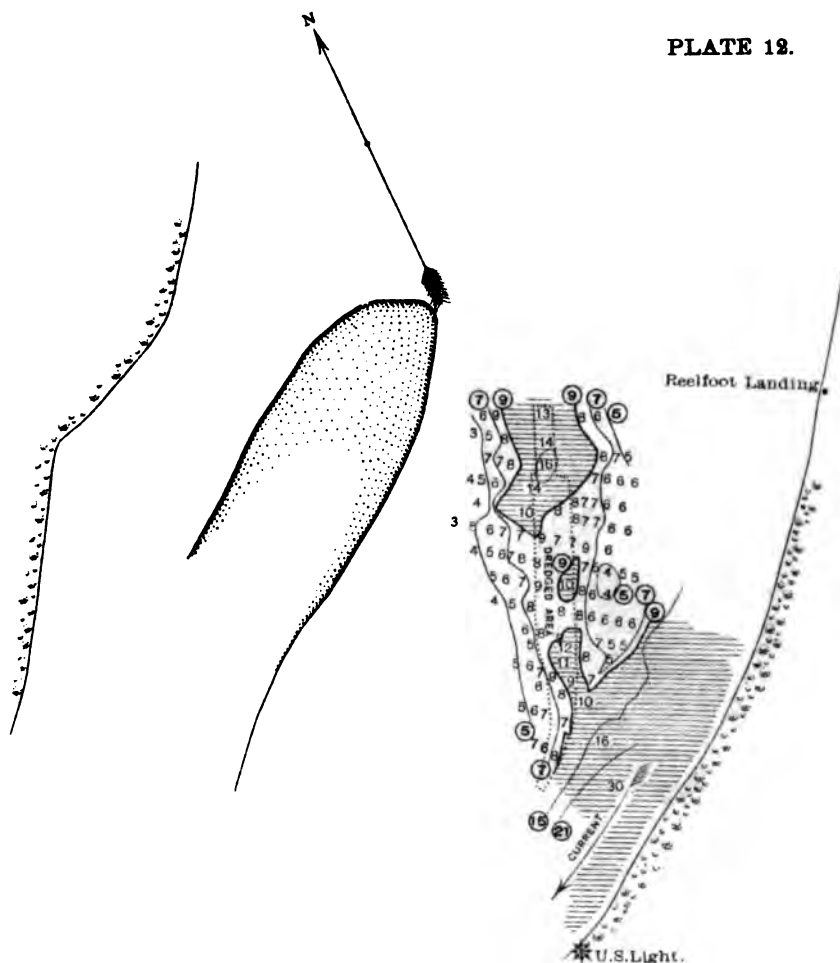
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 5.4 feet or 3.2 feet above mean low water.

Dotted areas indicate bare above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF
REELFOOT CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of November 7, 1901.

TWENTY-THREE DAYS AFTER DREDGING—SECOND TIME.

SCALE OF FEET.



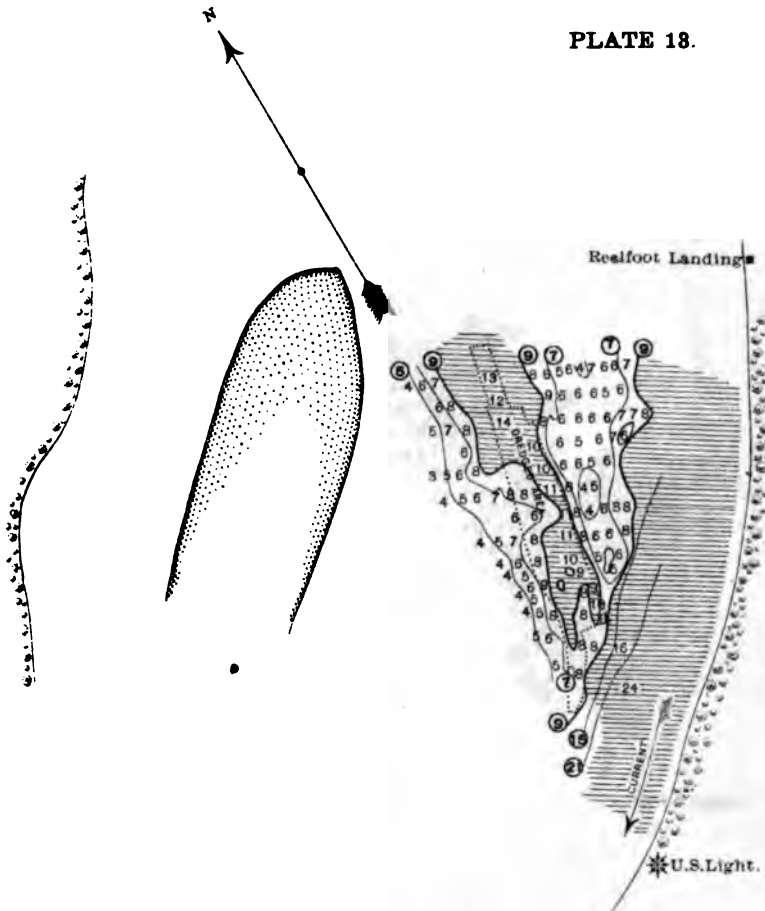
NOTES.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.8 feet or 1.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2

PLATE 18.



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

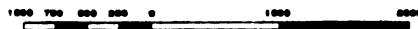
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1901.

DURING DREDGING--THIRD TIME.

SCALE OF FEET.

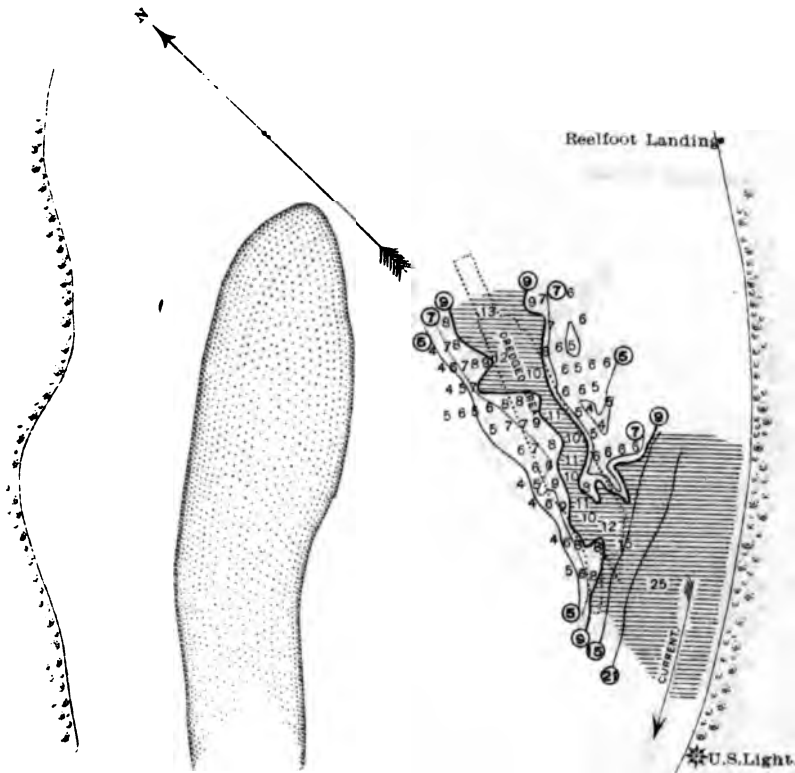


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.3 feet.

Gage at time of survey was 3.5 feet or 1.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF
REELFOOT CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of November 18, 1901.

THREE DAYS AFTER DREDGING—THIRD TIME.

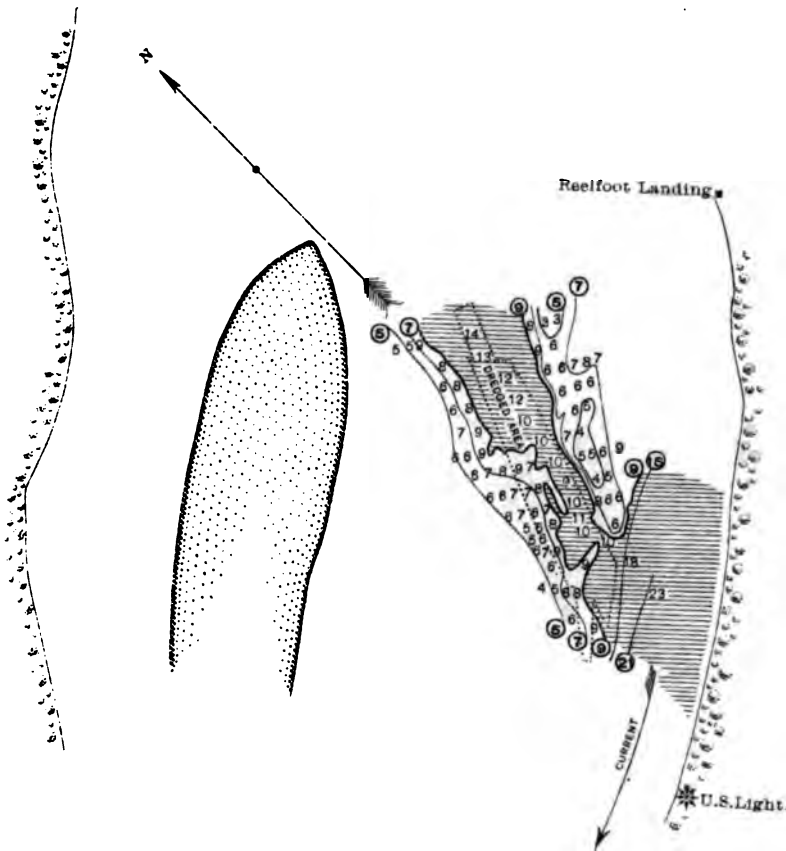
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.4 feet or 1.2 feet above mean low water.

Dotted areas indicate bars above mean low water. **Eng 57 2**



MISSISSIPPI RIVER COMMISSION.
 MAP OF
REELFOOT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of November 23, 1901.
 EIGHT DAYS AFTER DREDGING—THIRD TIME.
 SCALE OF FEET.

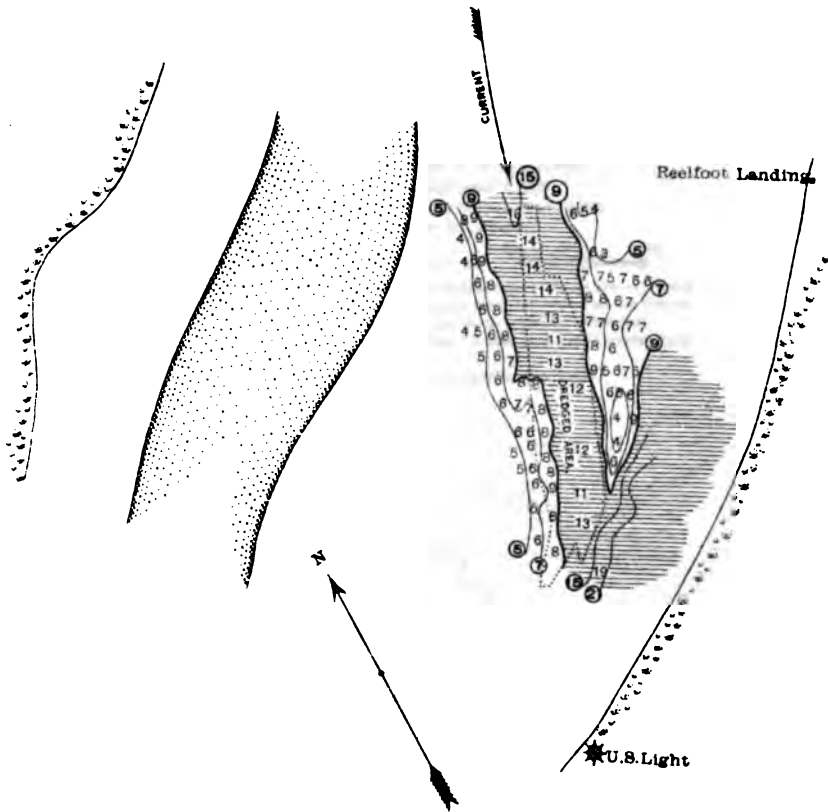
1000 750 500 250 0 1000 2000

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.9 feet or 0.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.
 MAP OF
REELFOOT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of November 30, 1901.
 ONE DAY AFTER DREDGING—FOURTH TIME.
 SCALE OF FEET.



Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

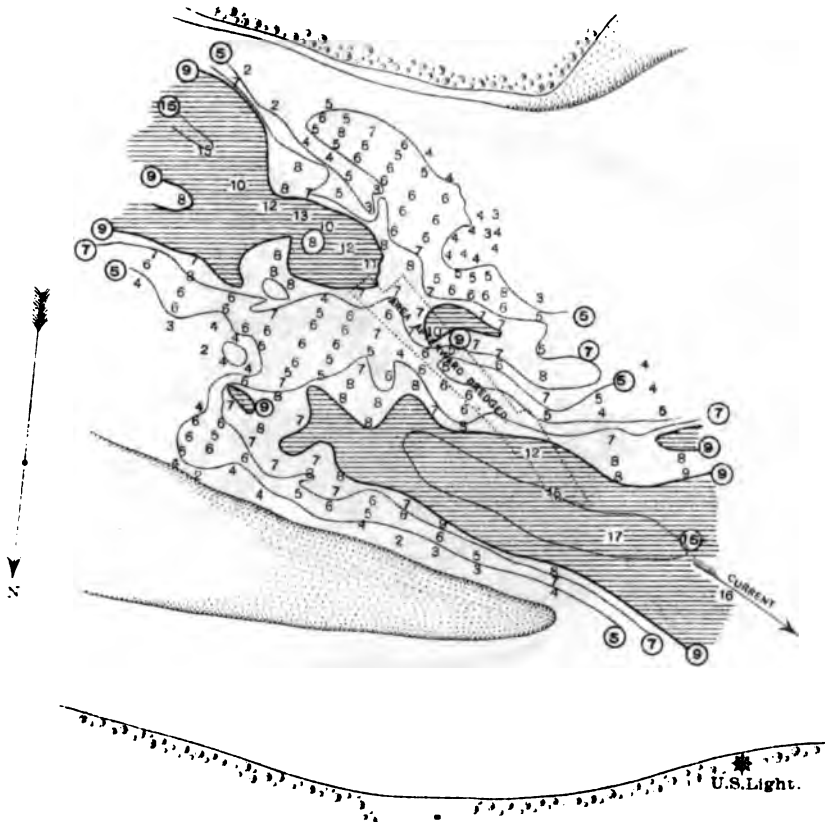
Gage at time of survey was 2.7 feet or 0.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATHAWAYS CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 9, 1901.
 TWO DAYS BEFORE DREDGING—FIRST TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.
 Gage at time of survey was 7.8 feet or 7.4 feet above mean low water.
 Dotted areas indicate bars above mean low water.



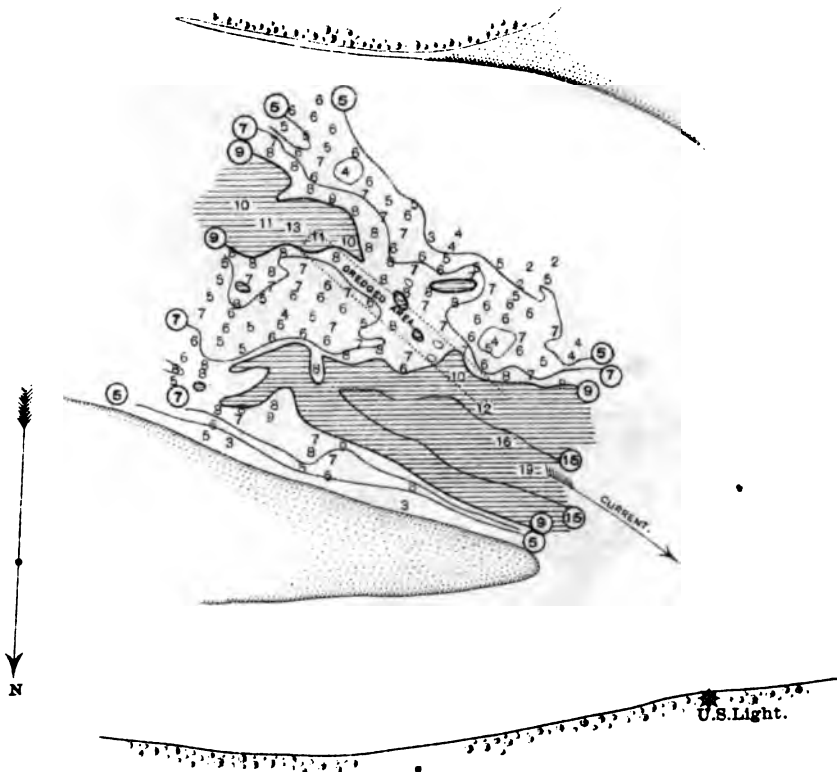
MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATHAWAYS CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 19, 1901.
 FOUR DAYS AFTER DREDGING—FIRST TIME.
 SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 6.0 feet or 5.6 feet above mean low water.

Dotted areas indicate bars above mean low water.





MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATHAWAYS CROSSING.

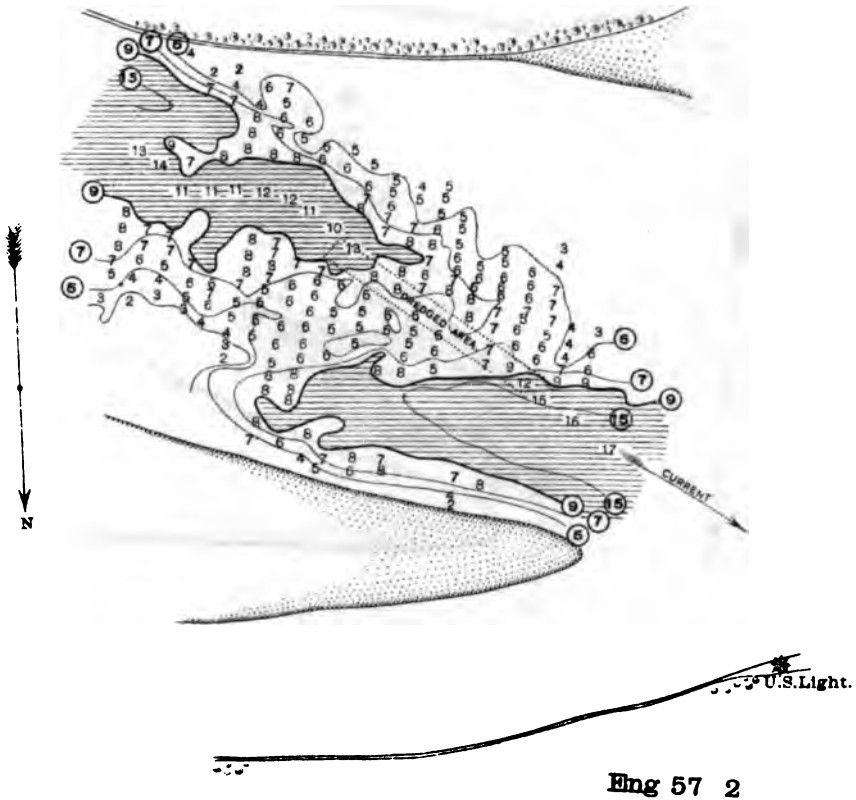
Made under direction of
CAPTAIN Q. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 9, 1901.
 EIGHTEEN DAYS AFTER DREDGING—FIRST TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 3.9 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



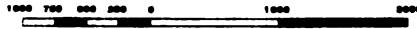
MISSISSIPPI RIVER COMMISSION.

MAP OF
HATHAWAYS CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of October 17, 1901.
ONE DAY AFTER DREDGING—SECOND TIME.

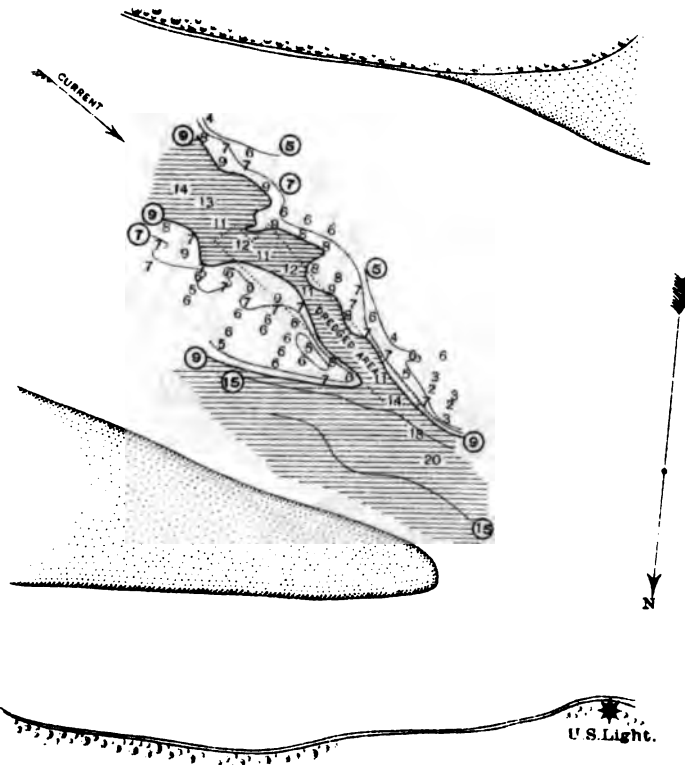
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 3.9 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATHAWAYS CROSSING,

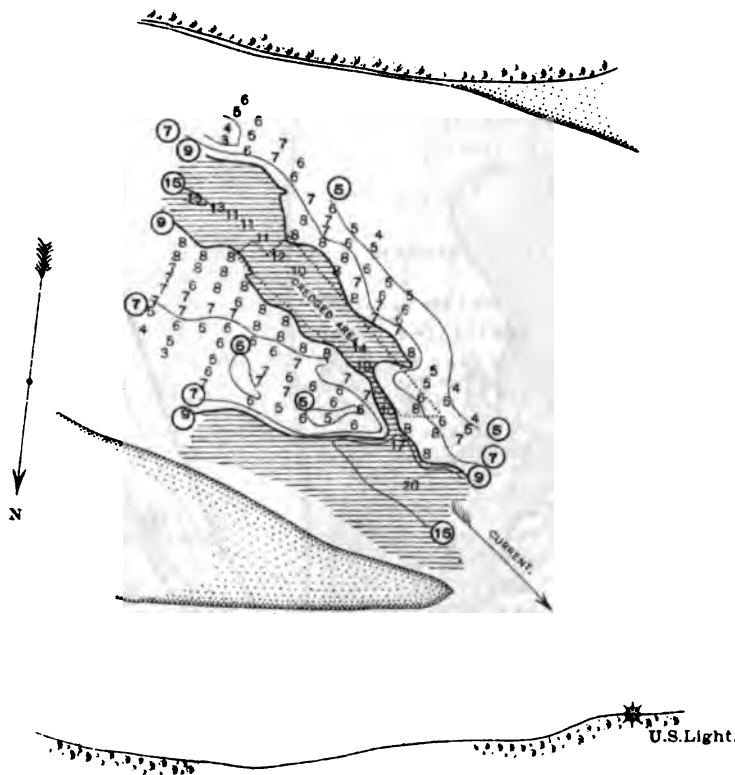
Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of November 5, 1901.
 NINETEEN DAYS AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 2.1 feet or 1.7 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF
HATHAWAYS CROSSING,

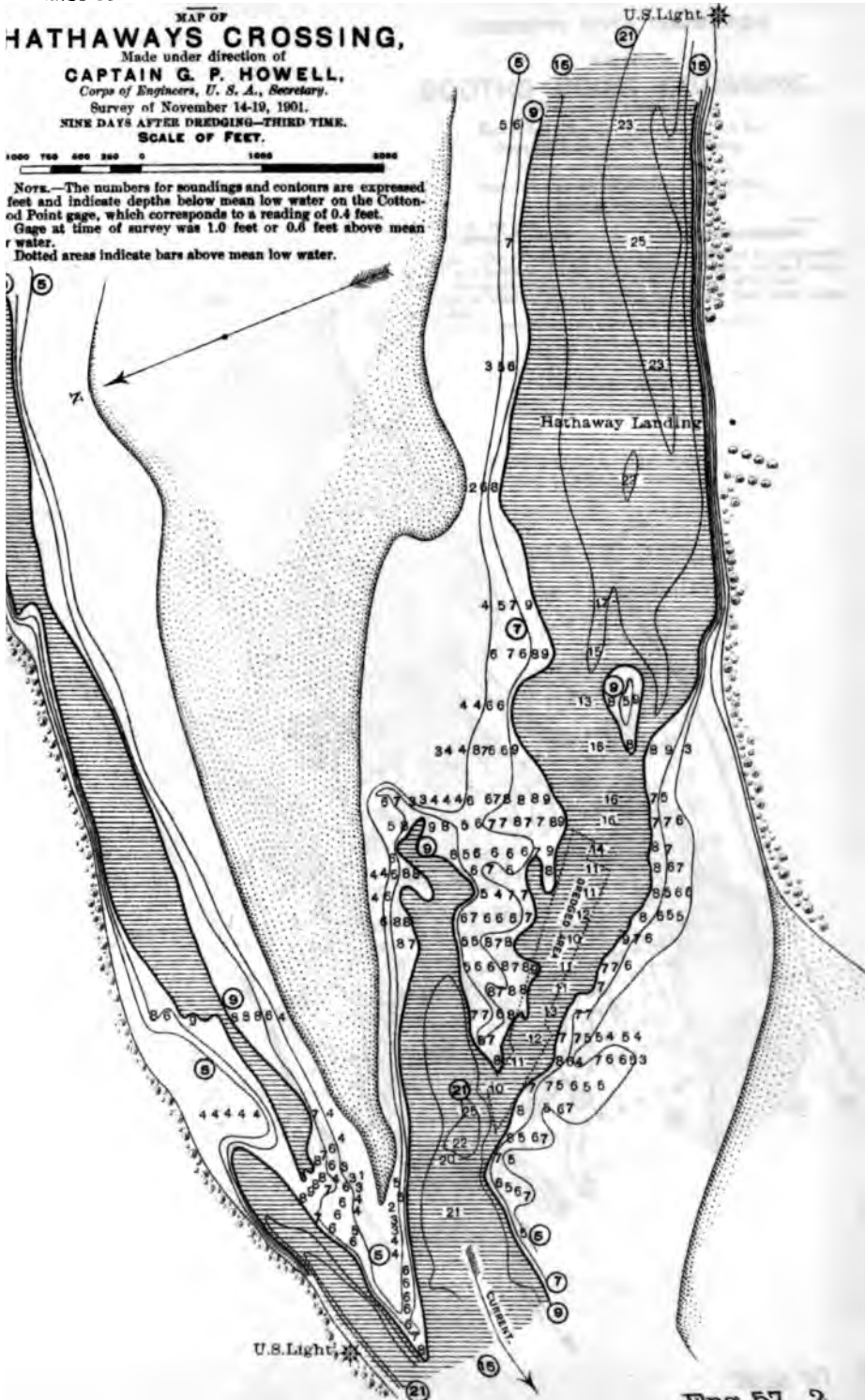
Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of November 14-19, 1901.
NINE DAYS AFTER DREDGING—THIRD TIME.
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet. Gage at time of survey was 1.0 foot or 0.6 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BOOTH'S POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18, 1901.

ONE DAY BEFORE DREDGING—FIRST TIME.

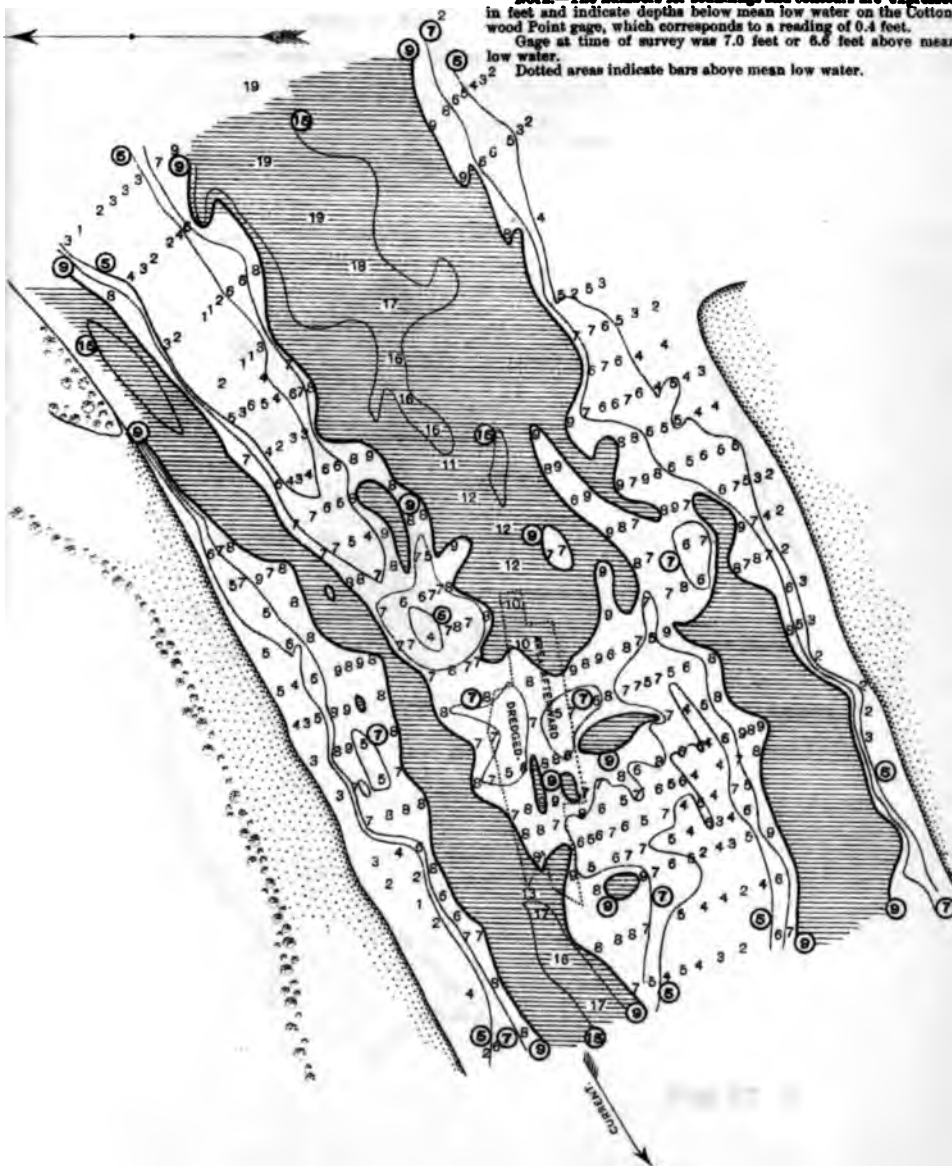
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 7.0 feet or 6.6 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BOOTH'S POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 22, 1901.

TWO DAYS AFTER DREDGING—FIRST TIME.

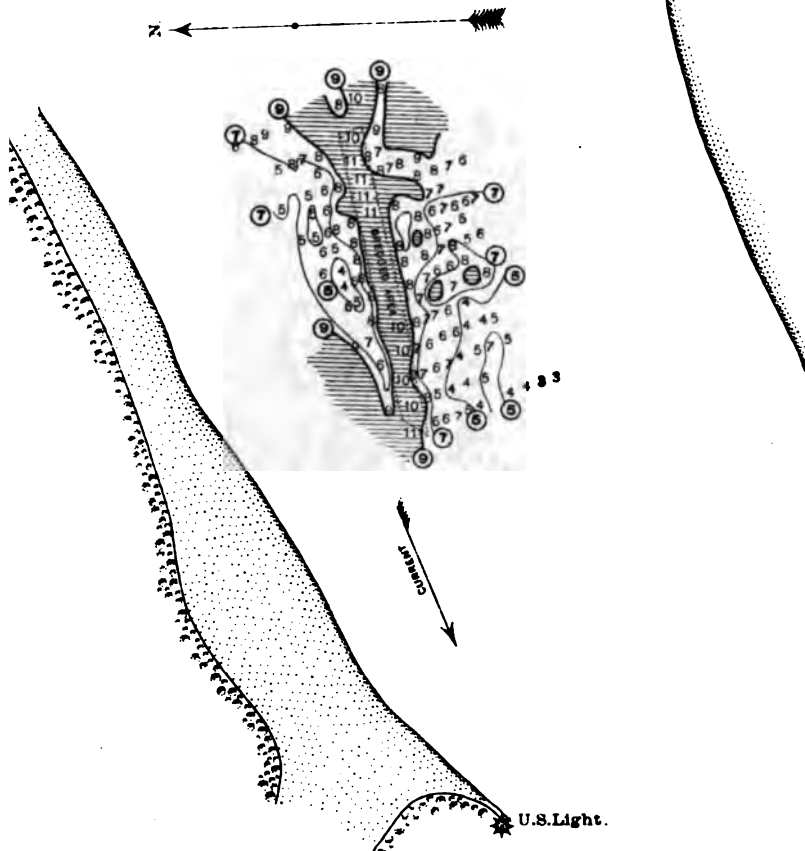
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 7.9 feet or 7.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BOOTH'S POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 2-4, 1901.

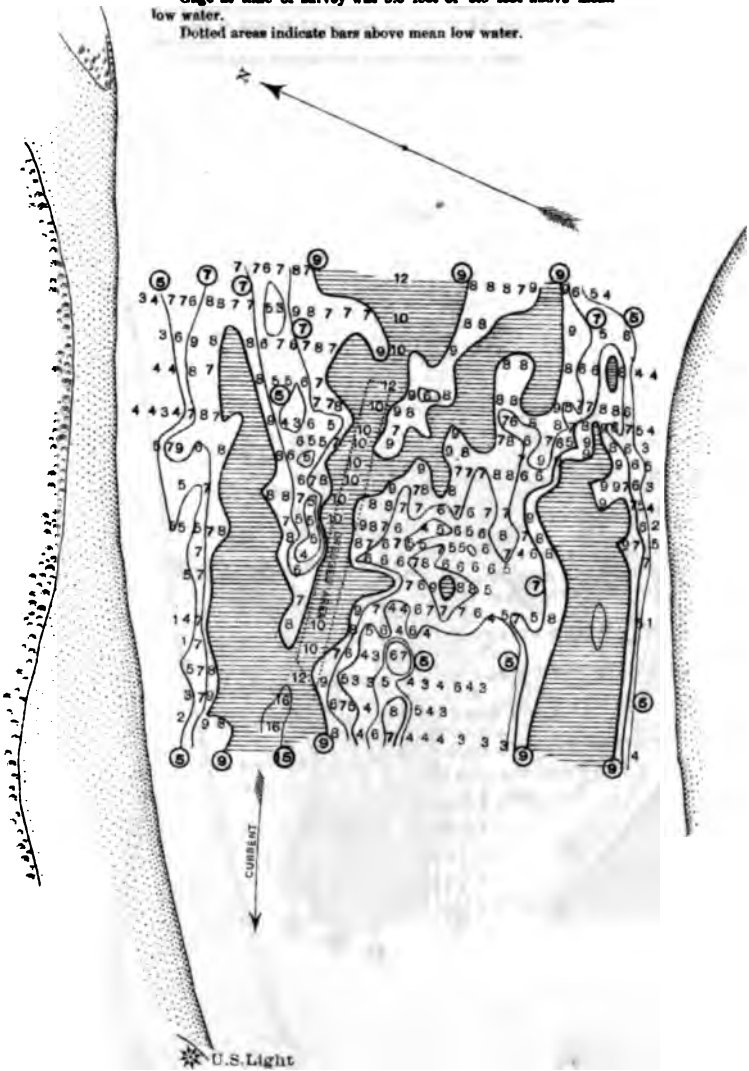
THIRTEEN DAYS AFTER BREWING—FIRST TIME.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet. Gage at time of survey was 6.0 feet or 5.6 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BOOTH'S POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 14, 1891.

THREE DAYS AFTER BREEDING—SECOND TIME.

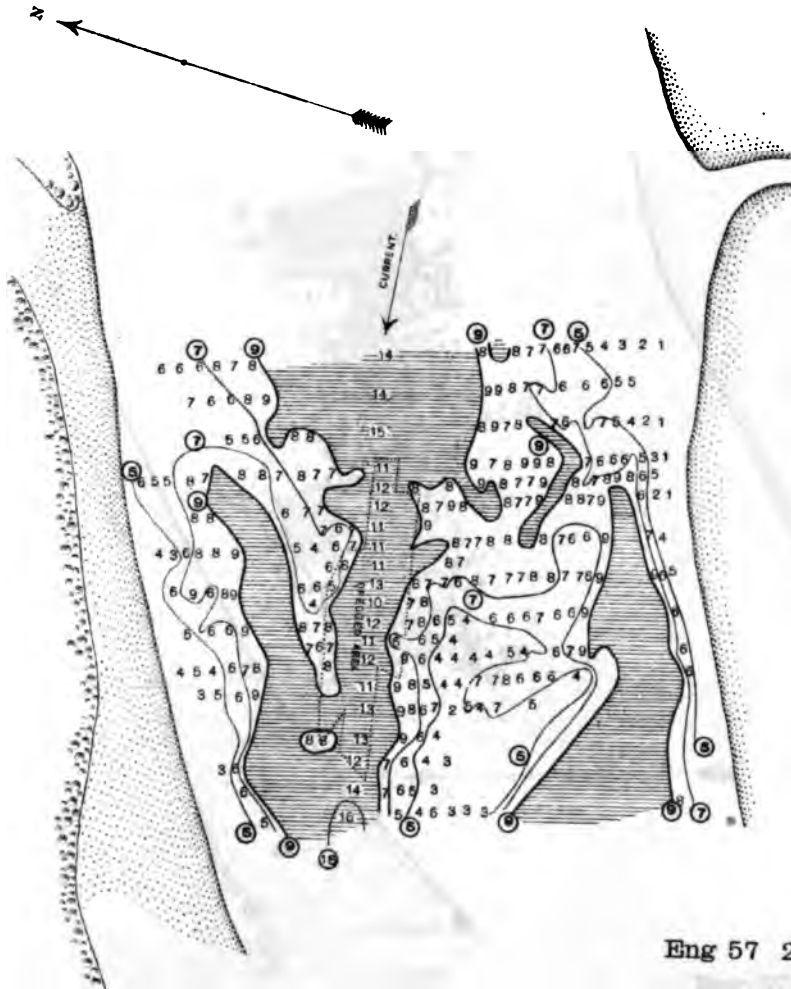
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 2.8 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BOOTH'S POINT CROSSING

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 4, 1901.

TWENTY-TWO DAYS AFTER BREWING—SECOND TIME.

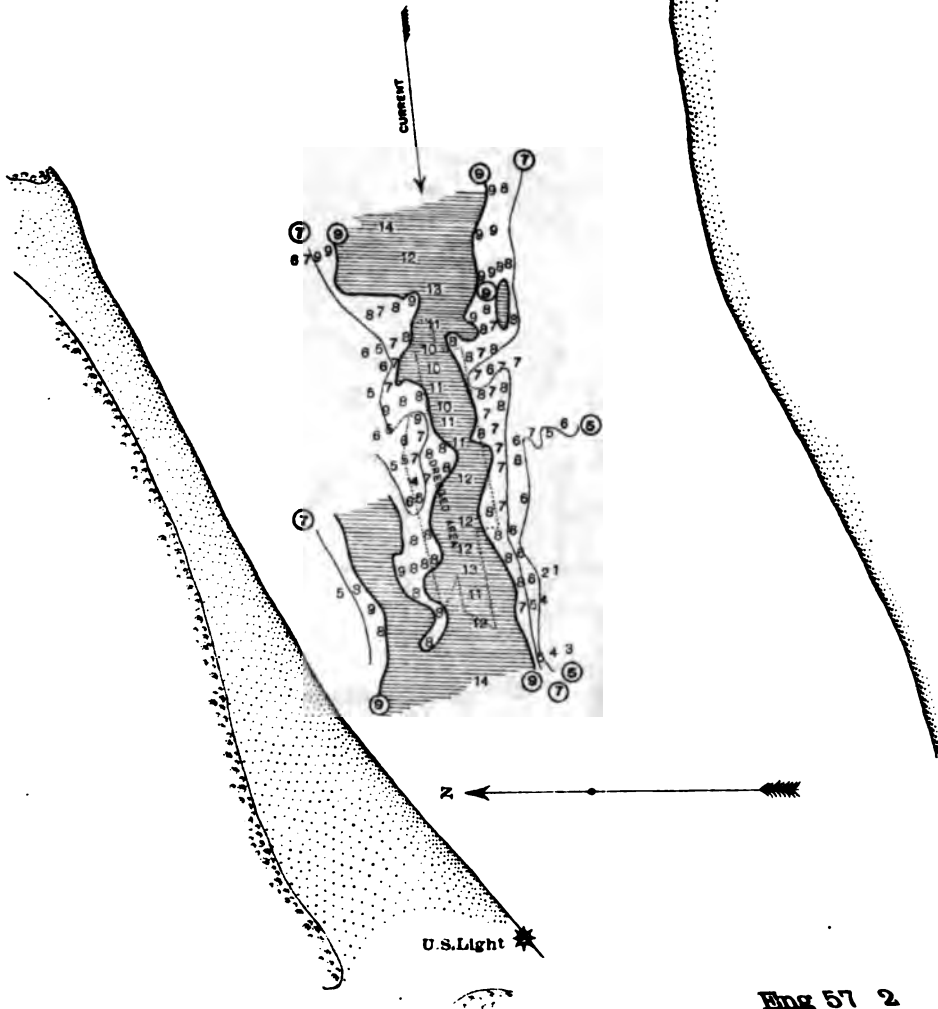
SCALE OF FEET.

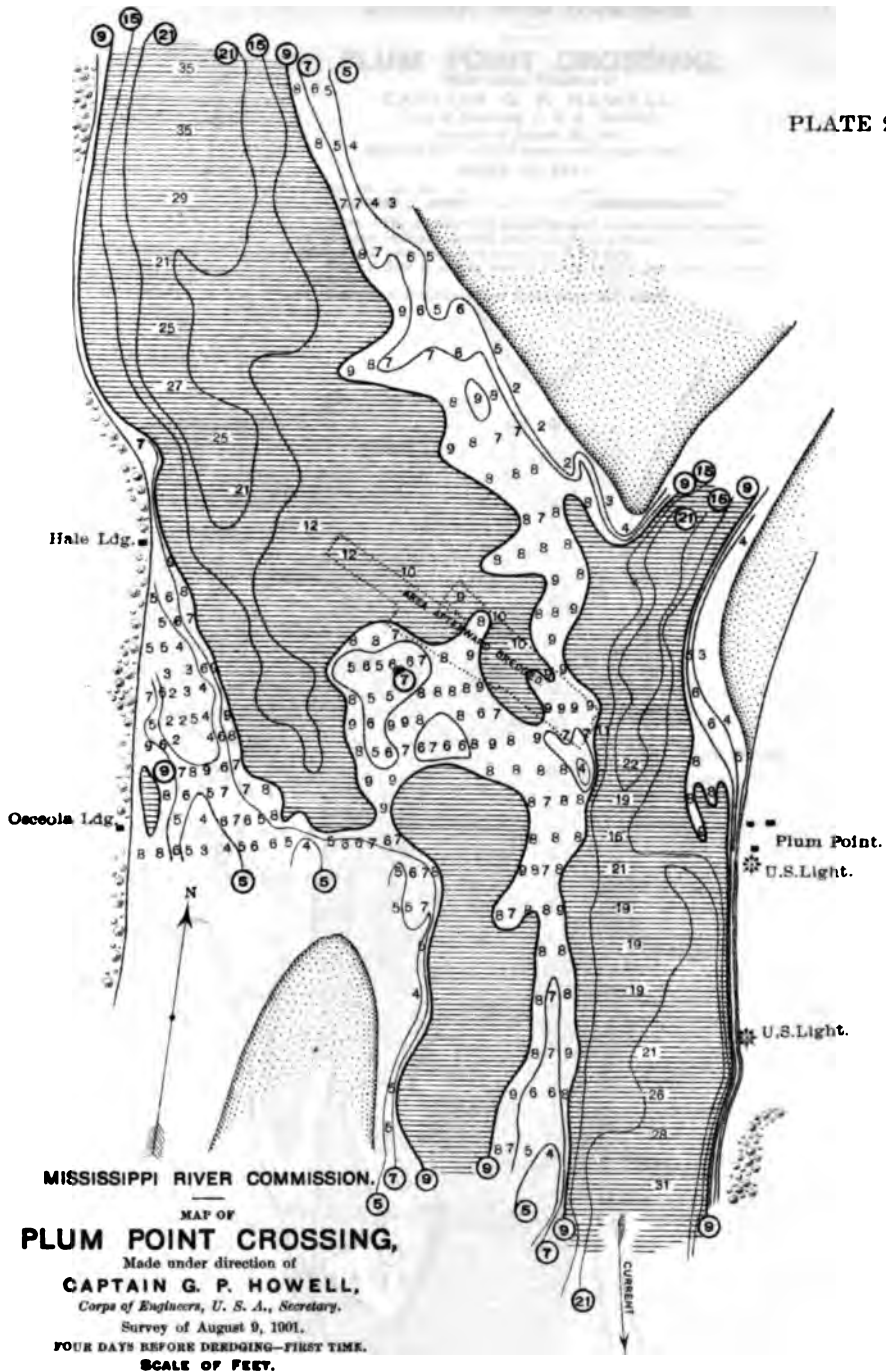


Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 1.9 feet or 1.5 feet above mean low water.

Dotted areas indicate bars above mean low water.





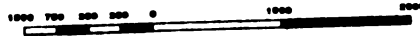
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gauge, which corresponds to a reading of 5.9 feet.
Gauge at time of survey was 6.0 feet or 2.1 feet above mean low water.
Dotted areas indicate bars above mean low water.

MAP OF PLUM POINT CROSSING,

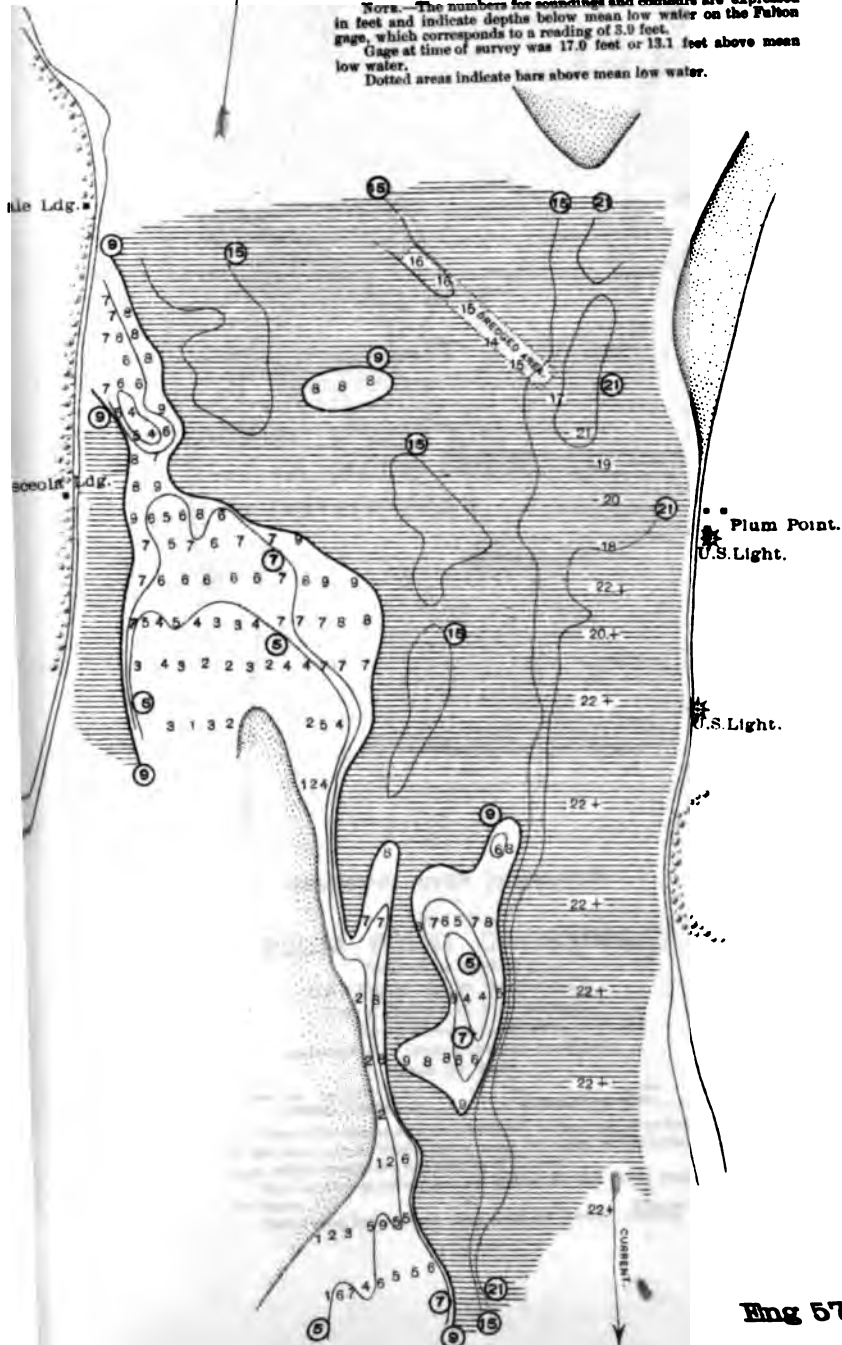
Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

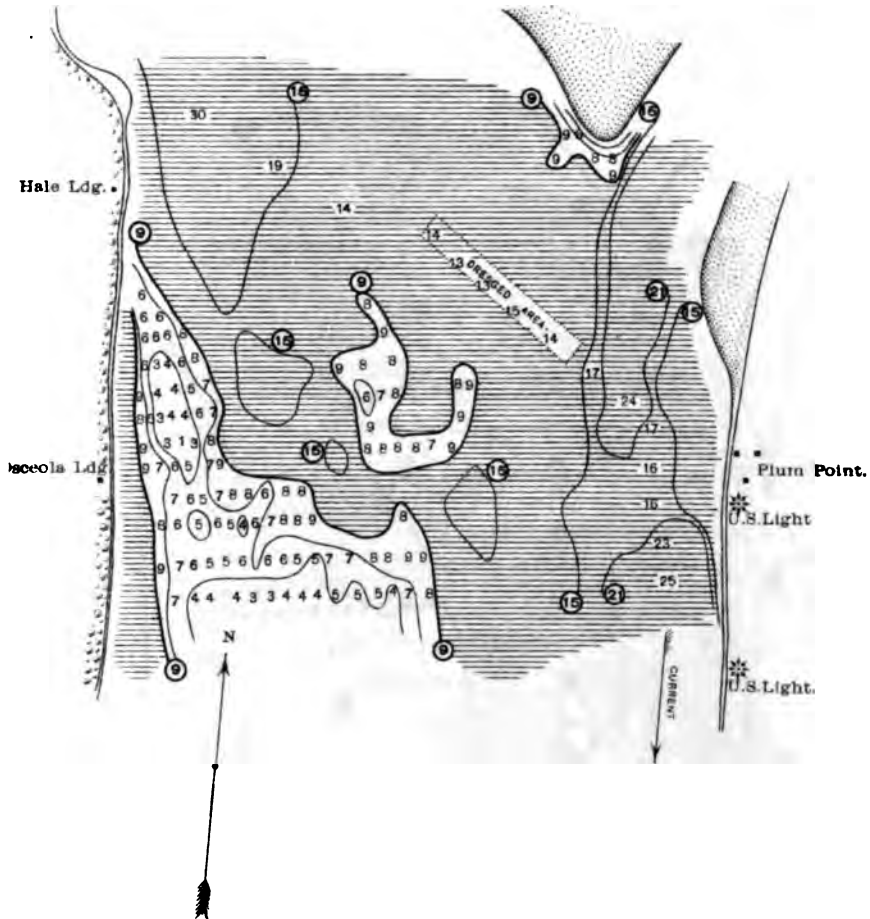
Survey of August 29, 1901.
ELEVEN DAYS AFTER DREDGING—FIRST TIME.

SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Falcon gage, which corresponds to a reading of 5.9 feet.
Gage at time of survey was 17.0 feet or 13.1 feet above mean low water.
Dotted areas indicate bars above mean low water.





MISSISSIPPI RIVER COMMISSION.
 MAP OF
PLUM POINT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 6, 1901.
 EIGHTEEN DAYS AFTER DREDGING—FIRST TIME.
 SCALE OF FEET.

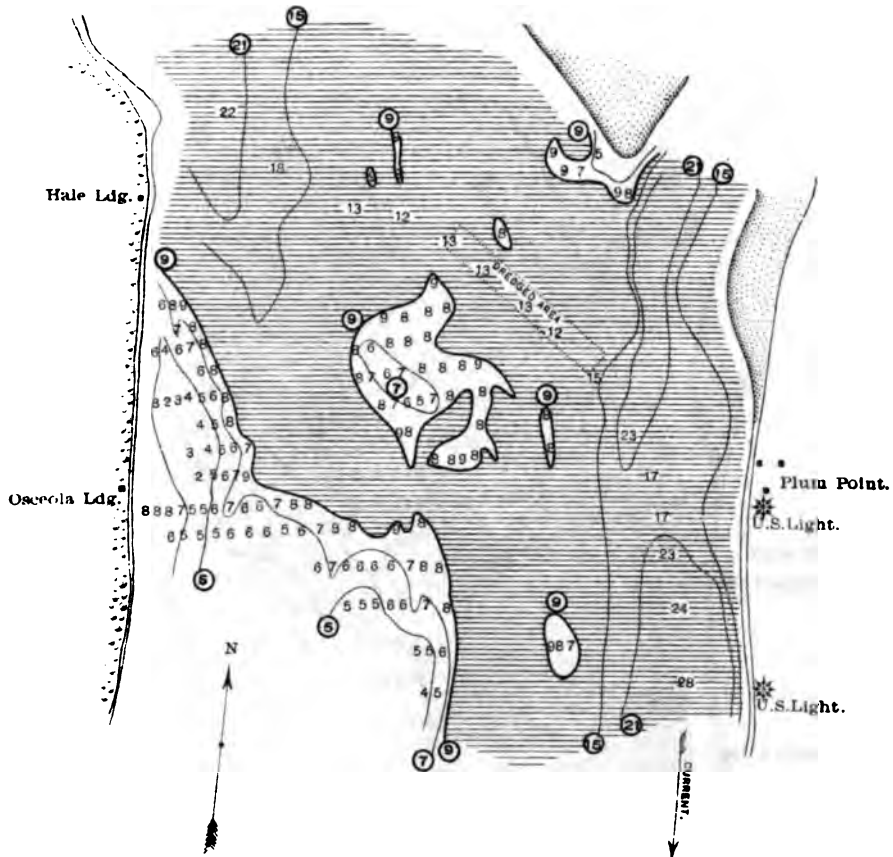


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 3.9 feet or 5.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

PLUM POINT CROSSING,

Made under direction of

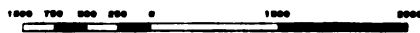
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 14, 1901.

ONE DAY BEFORE DREDGING—ABOUND TIME.

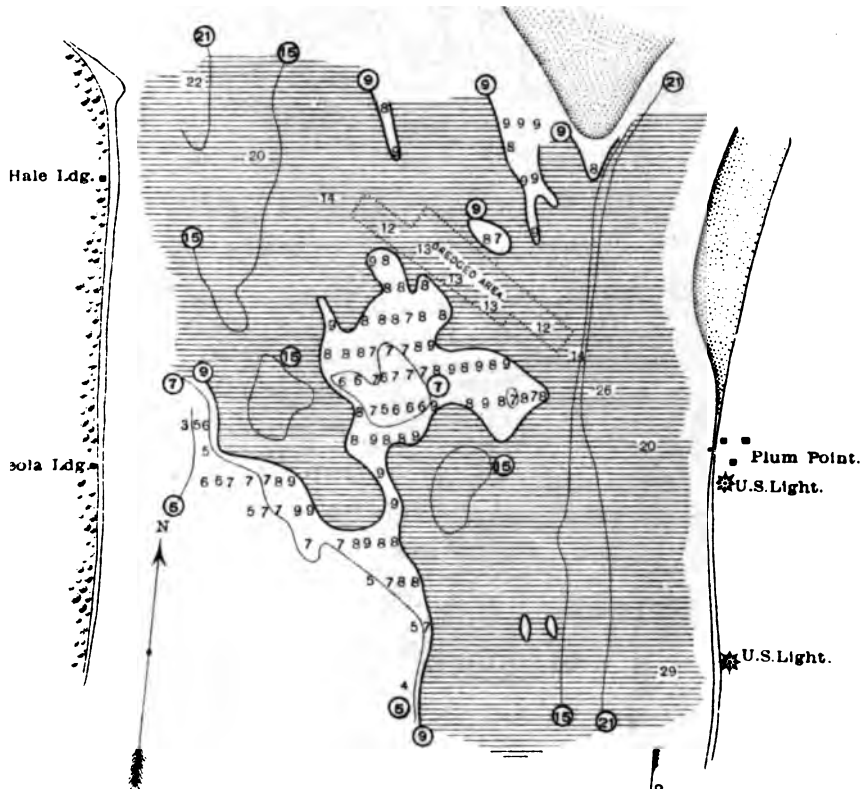
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 7.2 feet or 8.3 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.
 MAP OF
PLUM POINT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 30, 1901.
 ONE DAY AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.

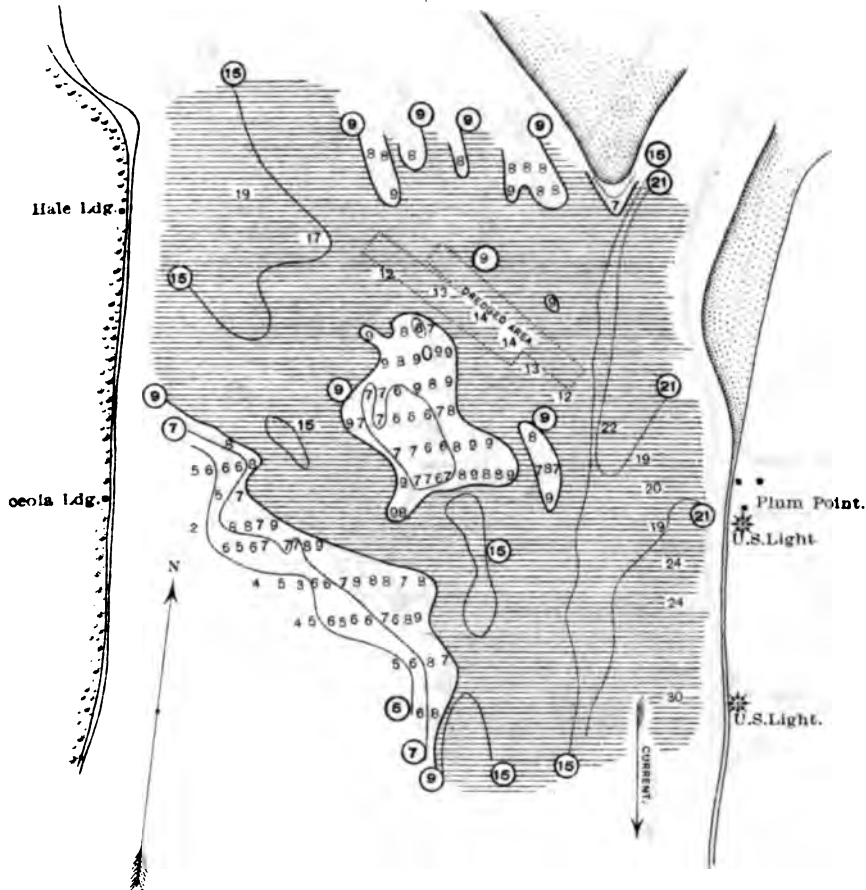
1000 700 500 300 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

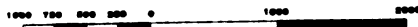
Gage at time of survey was 6.5 feet or 2.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



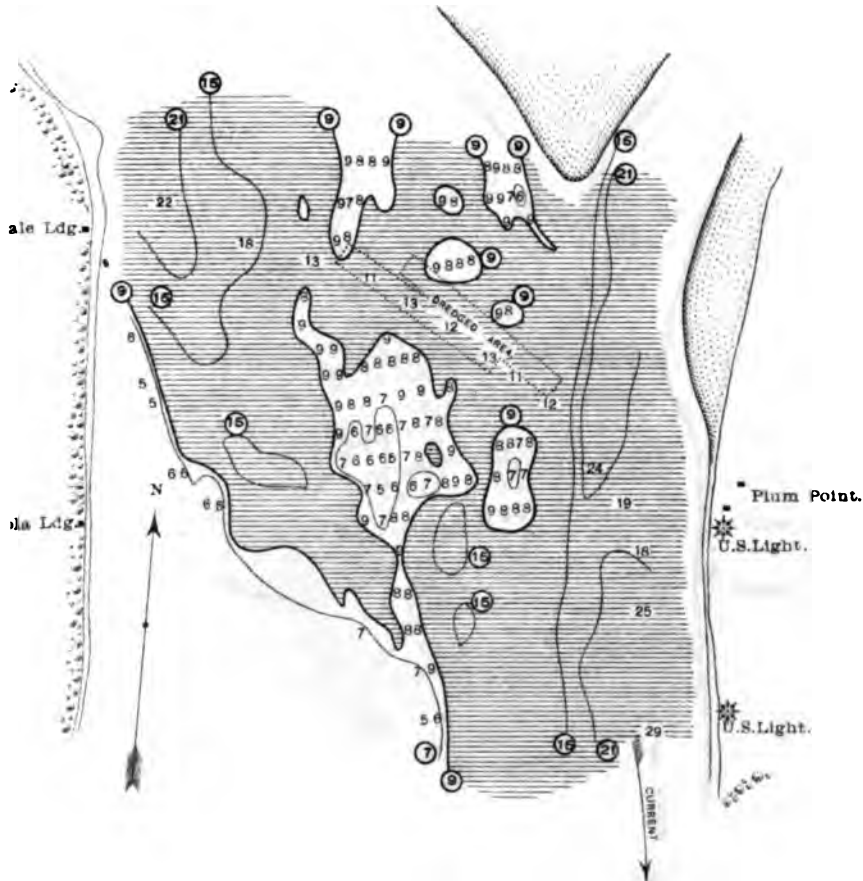
MISSISSIPPI RIVER COMMISSION.
 MAP OF
PLUM POINT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 30, 1901.
 TWELVE DAYS AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 5.9 feet or 5.0 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PLUM POINT CROSSING,

Made under direction of

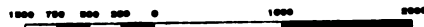
CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 6, 1901.

ONE DAY BEFORE DREDGING—THIRD TIME.

SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 3.6 feet or 1.7 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2

1

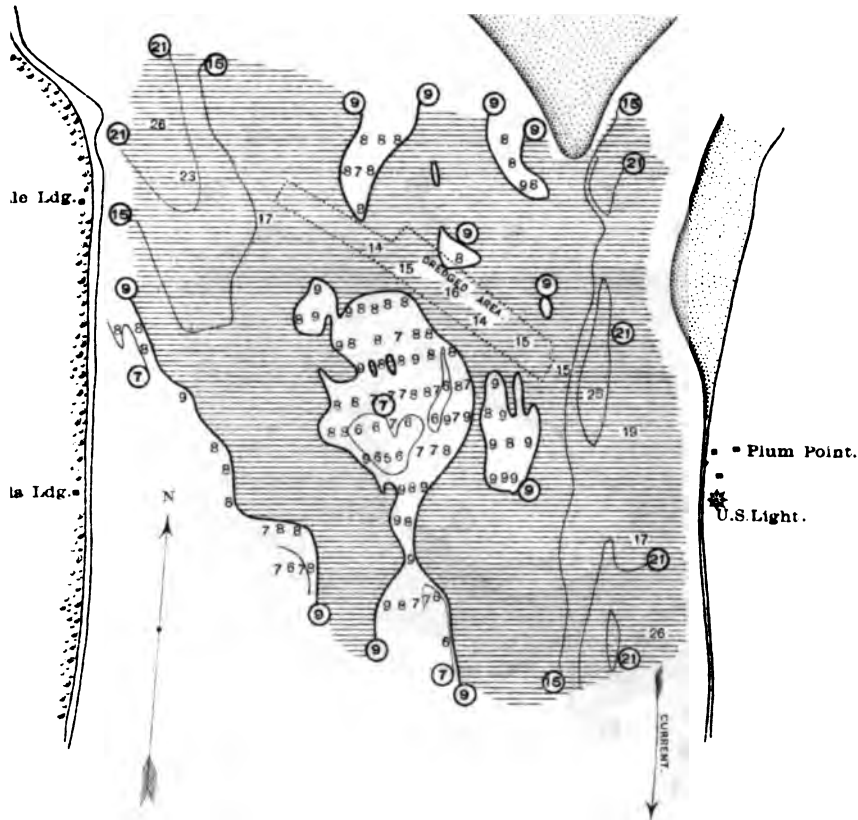
1

.

.

.

.



MISSISSIPPI RIVER COMMISSION.
 MAP OF
PLUM POINT CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 13, 1901.
 ONE DAY AFTER DREDGING—THIRD TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

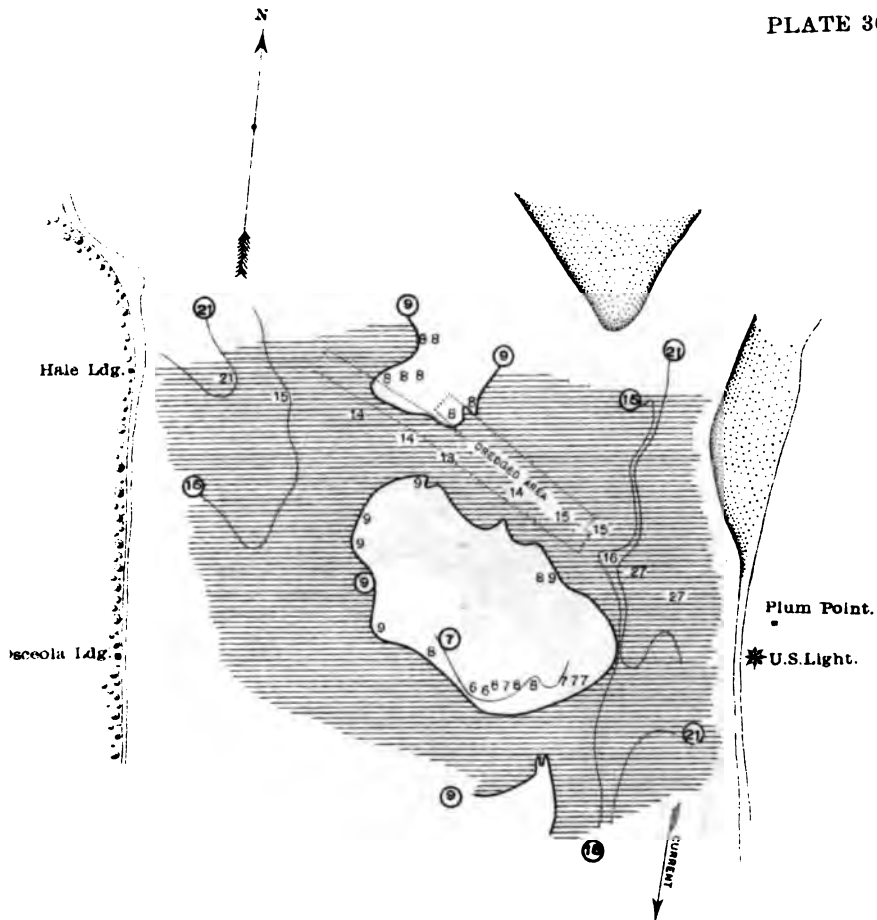
Gage at time of survey was 4.3 feet or 0.4 feet above mean low water.

Dotted areas indicate bars above mean low water. **Eng 57 2**

.

'

1



MISSISSIPPI RIVER COMMISSION.

MAP OF

PLUM POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 19, 1901.

ONE DAY BEFORE DREDGING—FOURTH TIME.

SCALE OF FEET.

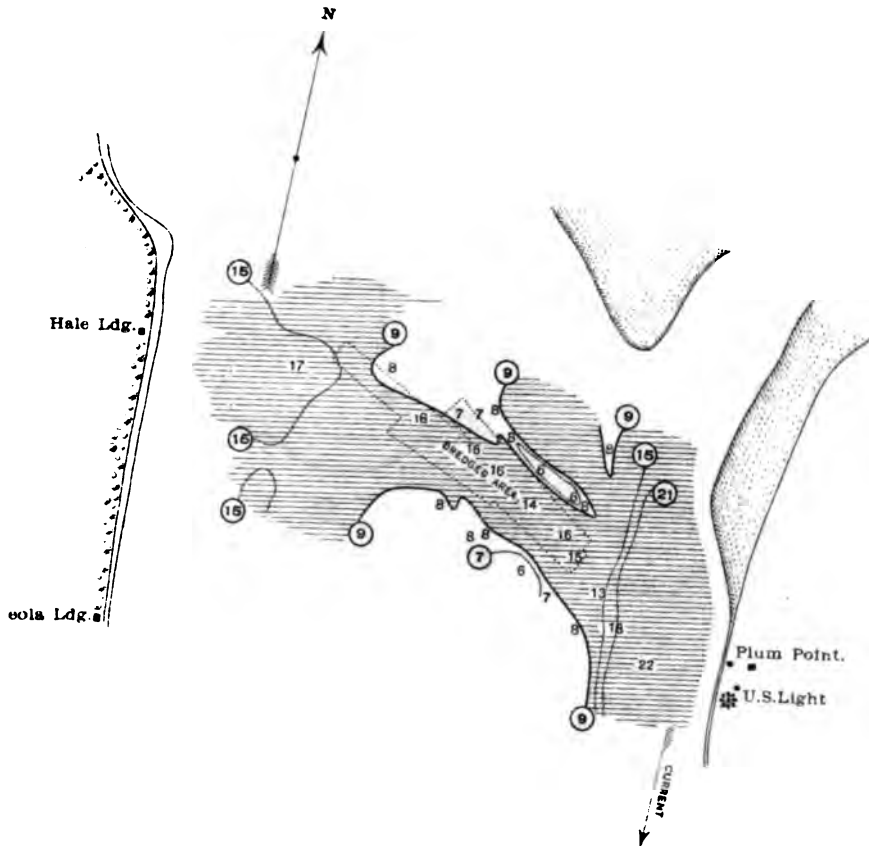


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 1.7 feet or 2.2 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

PLUM POINT CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 23, 1901.

ONE DAY AFTER DREDGING—FOURTH TIME.

SCALE OF FEET.

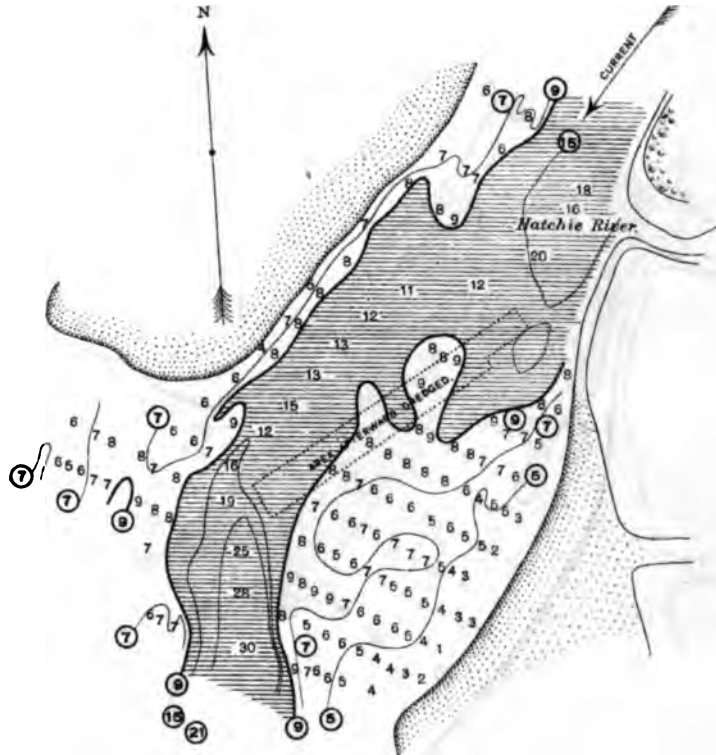


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 1.7 feet or 2.2 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2

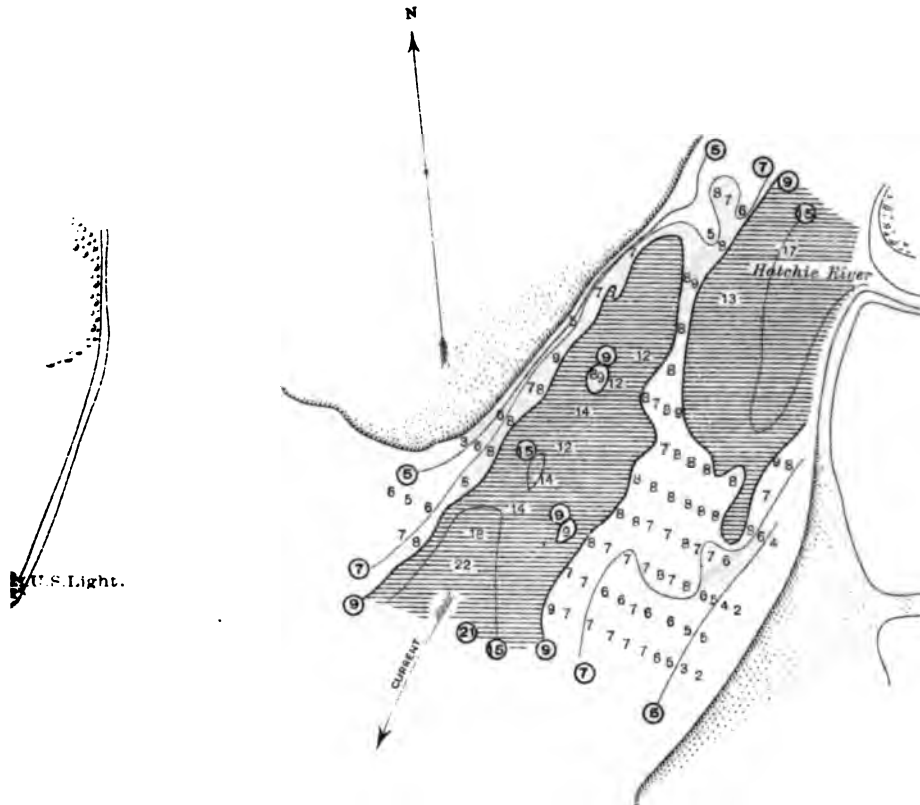


MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE RIVER CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 9, 1901.
 SEVEN DAYS BEFORE DREDGING—FIRST TIME.
 SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 8.1 feet or 4.2 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE RIVER CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 18, 1901.
 THREE DAYS BEFORE DREDGING—FIRST TIME.
 SCALE OF FEET.

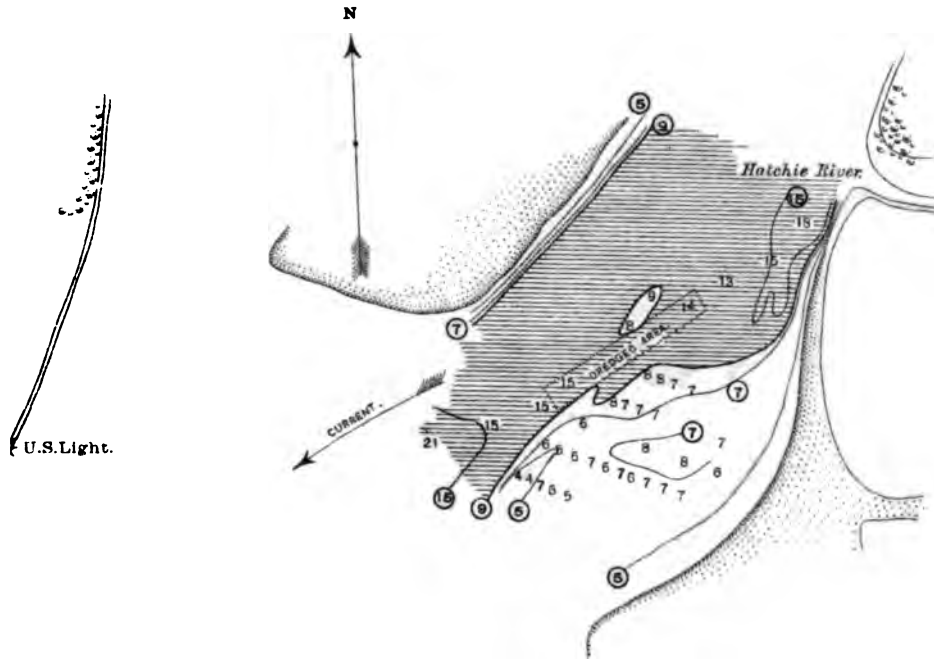
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 7.4 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE RIVER CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18, 1901.

DURING DREDGING—FIRST TIME.

SCALE OF FEET.

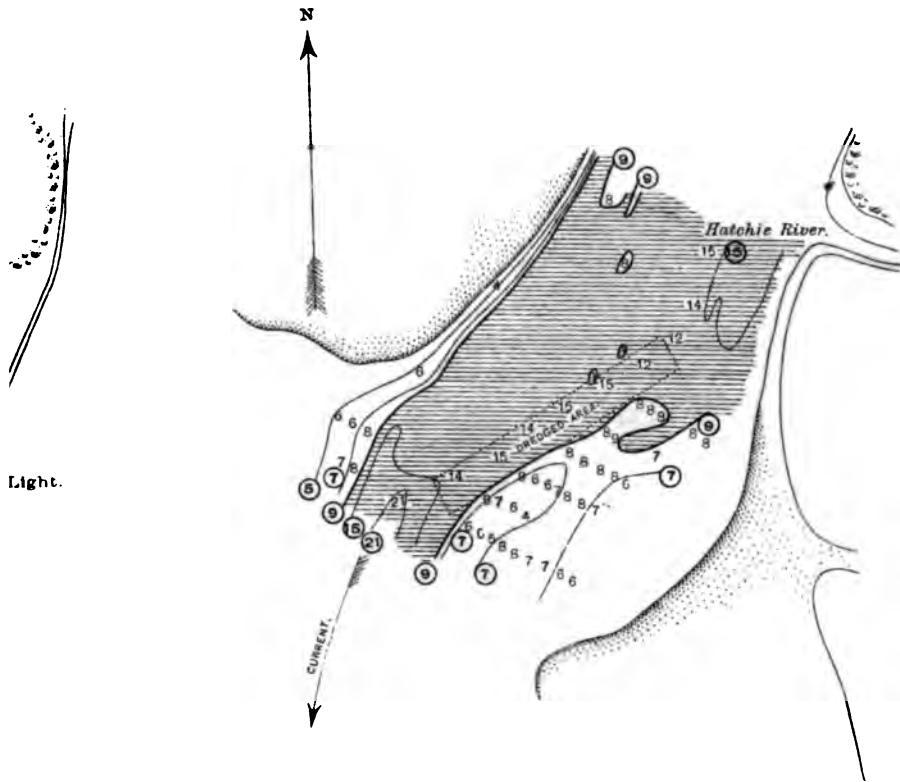
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 6.0 feet or 2.1 feet above mean low water.

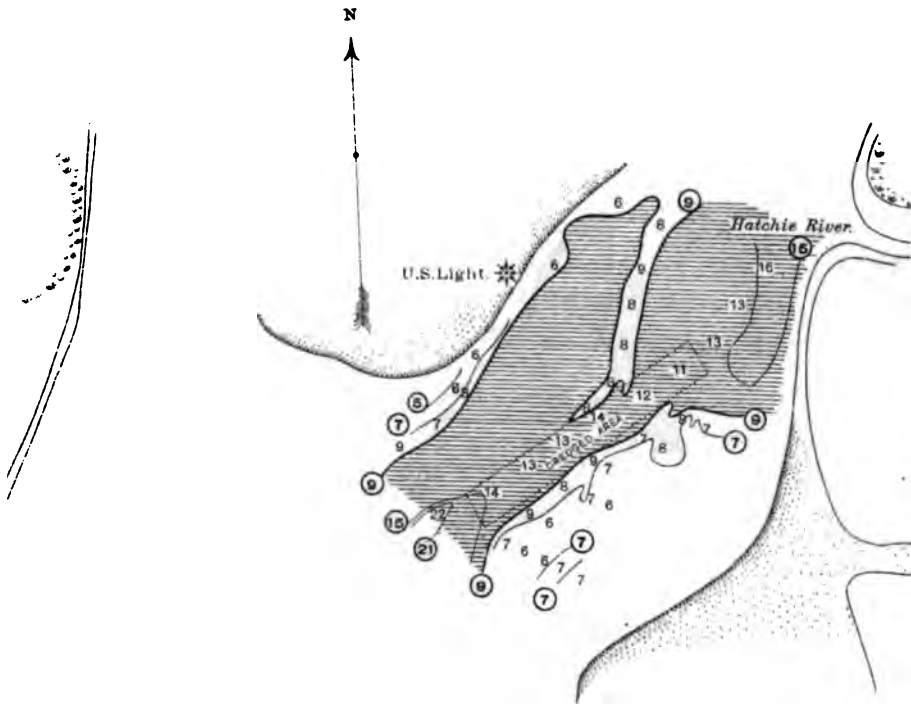
Dotted areas indicate bars above mean low water. Eng 57 2

•



MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE RIVER CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 22, 1901.
 ONE-HALF DAY AFTER DREDGING—FIRST TIME.
 SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.
 Gage at time of survey was 7.8 feet or 3.9 feet above mean low water.
 Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE RIVER CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 5, 1901.

ONE DAY BEFORE DREDGING—SECOND TIME.

SCALE OF FEET.

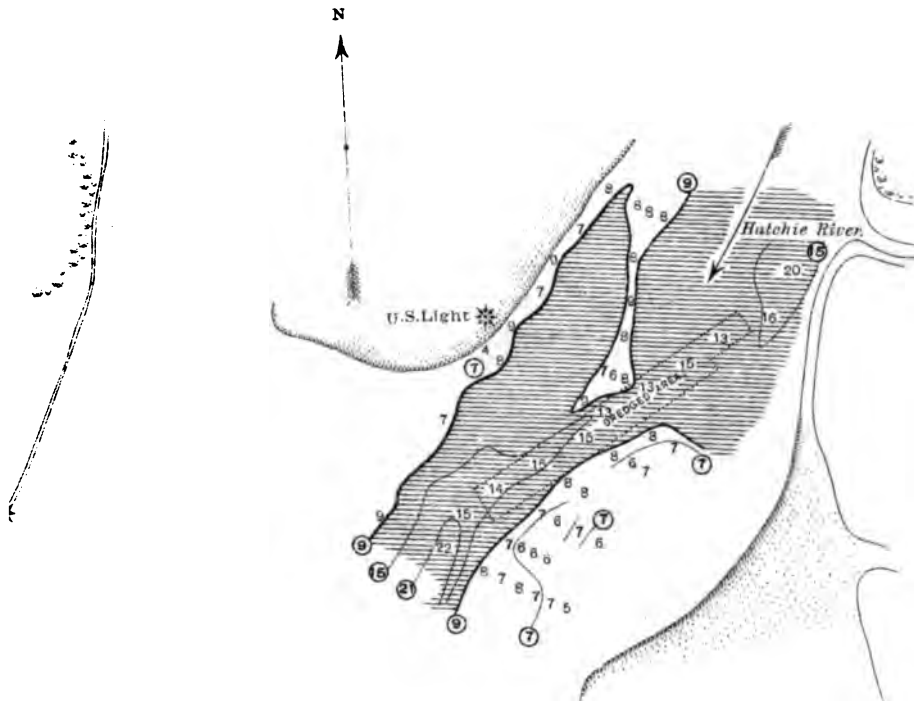
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 6.2 feet or 2.3 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2





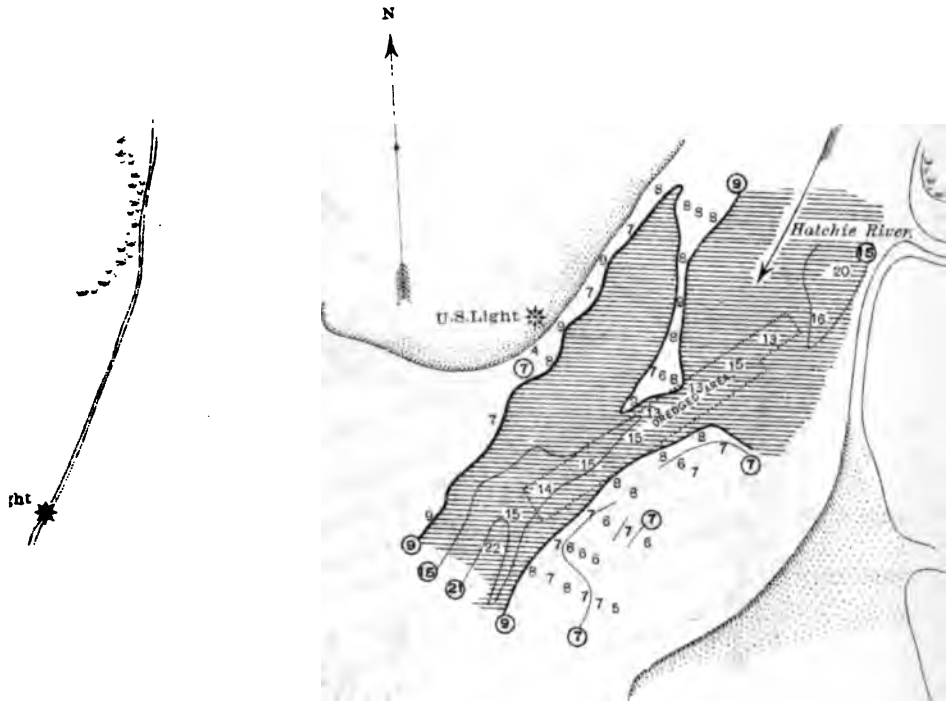
MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE RIVER CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 14, 1901.
 FIVE DAYS AFTER DREDGING—SOUND TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 4.8 feet or 0.9 feet above mean low water.

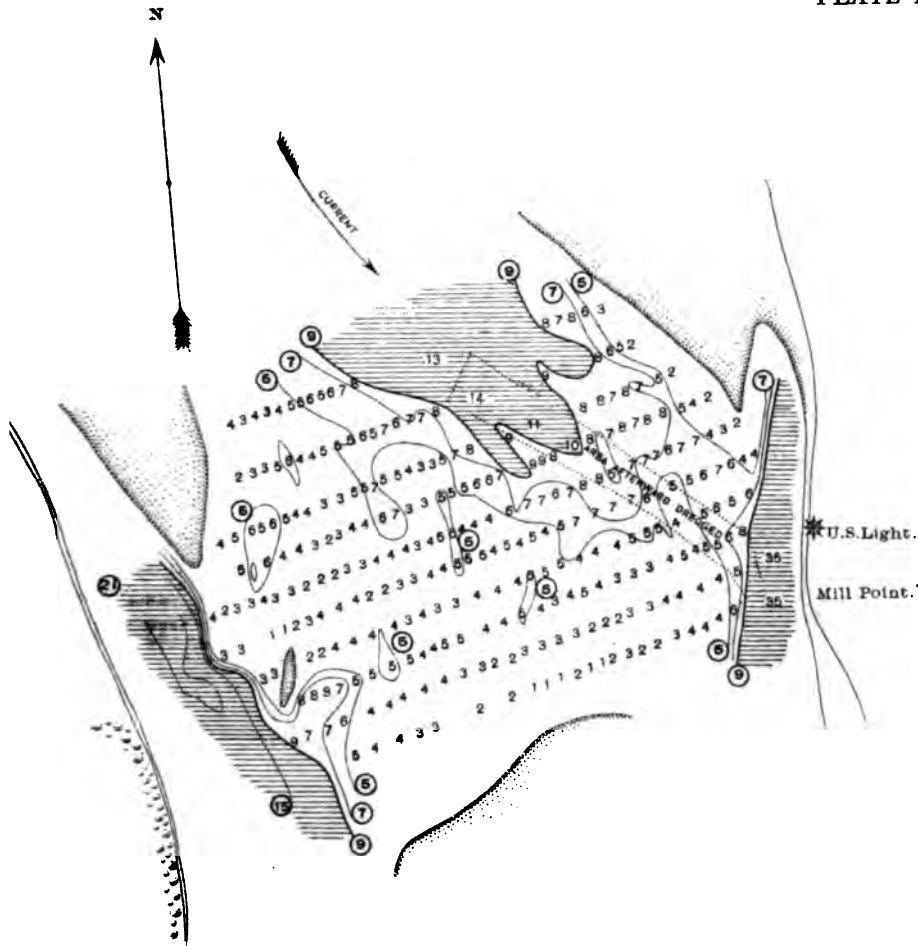
Dotted areas indicate bars above mean low water. **Eng 57 2**



MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE RIVER CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 14, 1901.
 FIVE DAYS AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.
 Gage at time of survey was 4.8 feet or 0.9 foot above mean low water.
 Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.
 MAP OF
HATCHIE ISLAND CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of August 5, 1901.
 FIVE DAYS BEFORE DREDGING—FIRST TIME.
 SCALE OF FEET.

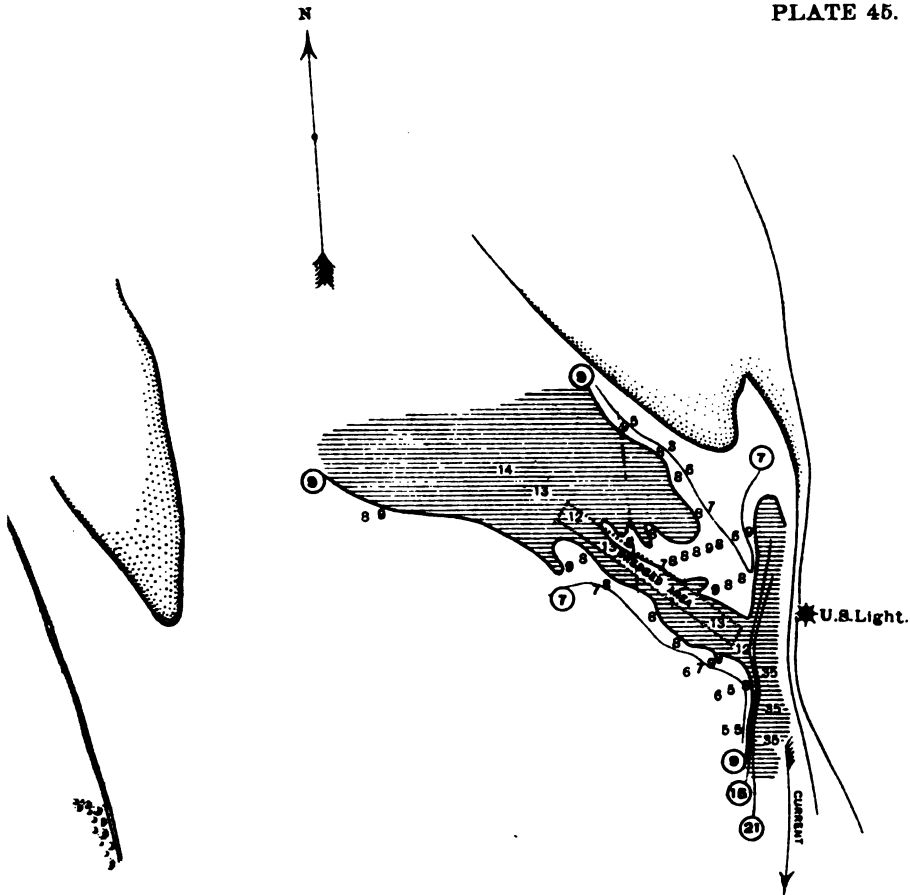
1000 700 600 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 6.6 feet or 2.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of August 10, 1901.

ONE DAY AFTER FLOODING—FIRST TIME.

SCALE OF FEET.

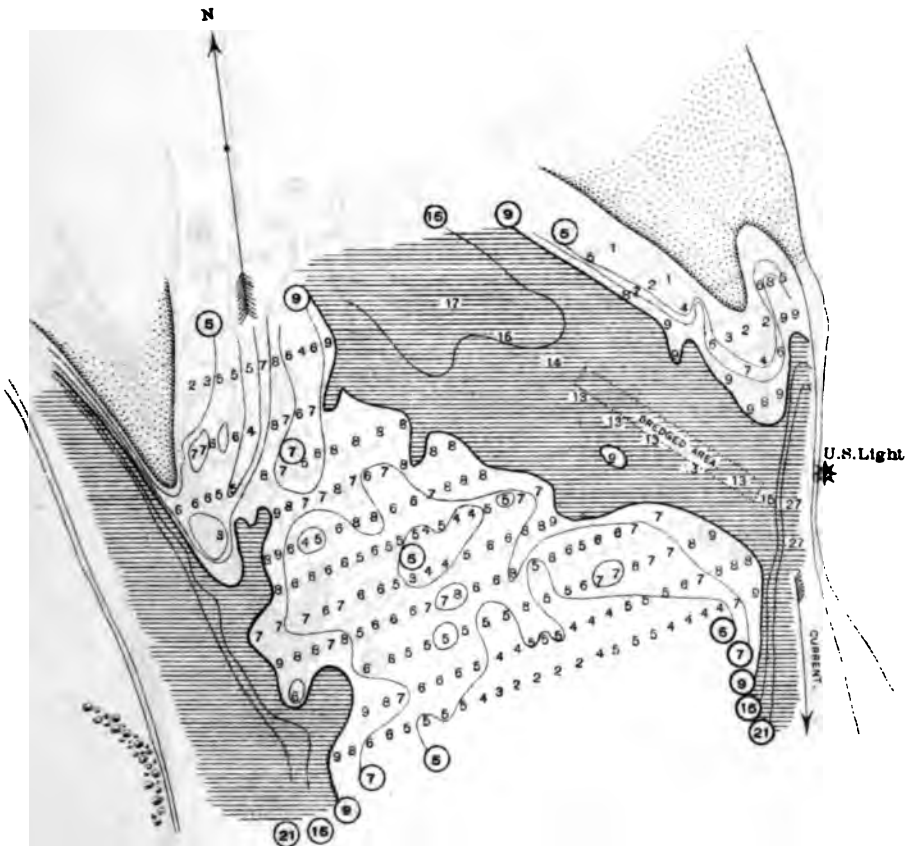


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 2.9 feet.

Gage at time of survey was 7.0 feet or 2.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 3, 1901.

SIXTEEN DAYS AFTER DREDGING—FIRST TIME.

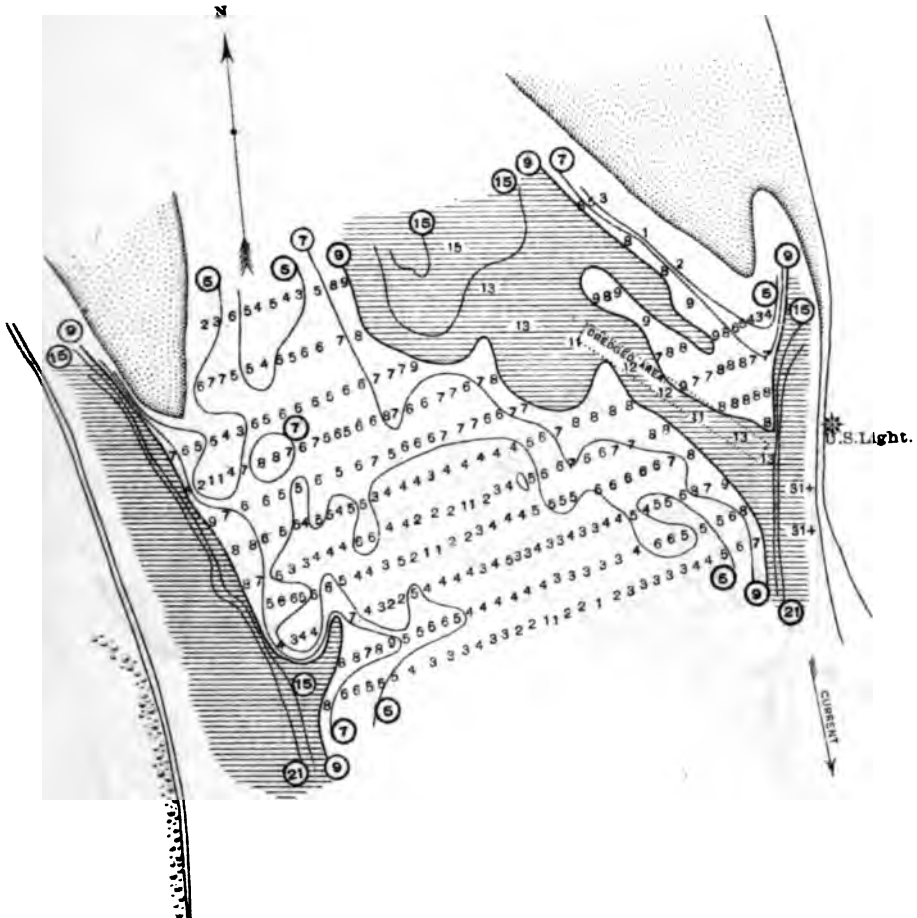
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 12.5 feet or 3.6 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



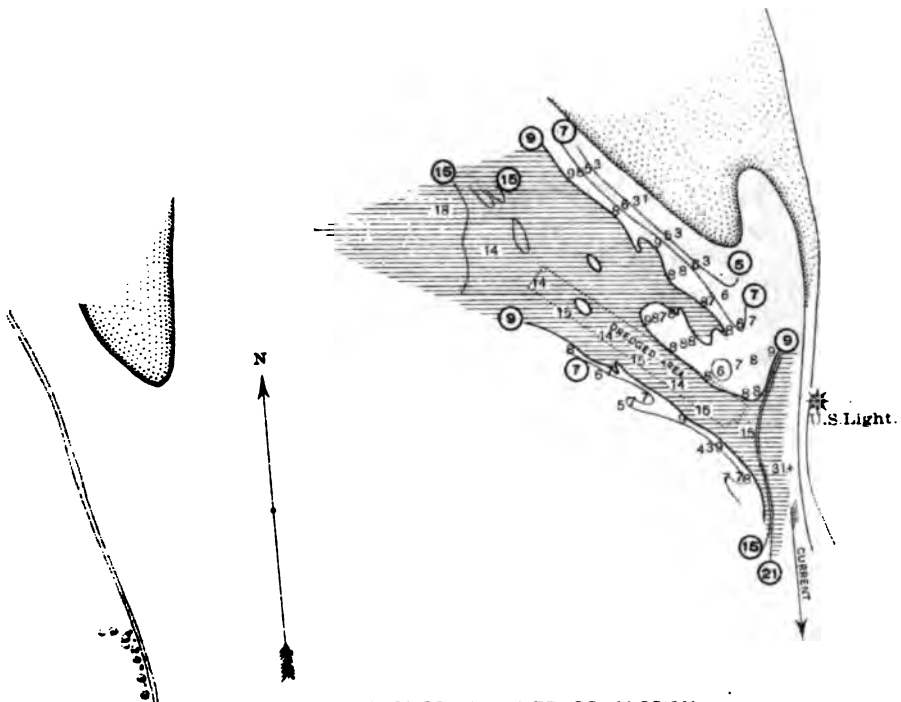
MISSISSIPPI RIVER COMMISSION.
 MAP OF
 HATCHIE ISLAND CROSSING,
 Made under direction of
 CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of September 9, 1901.
 ONE DAY BEFORE DREDGING—SECOND TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 3.1 feet or 4.3 feet above mean low water.

Dotted areas indicate bars above mean low water.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 12, 1901.

DURING DREDGING—SECOND TIME.

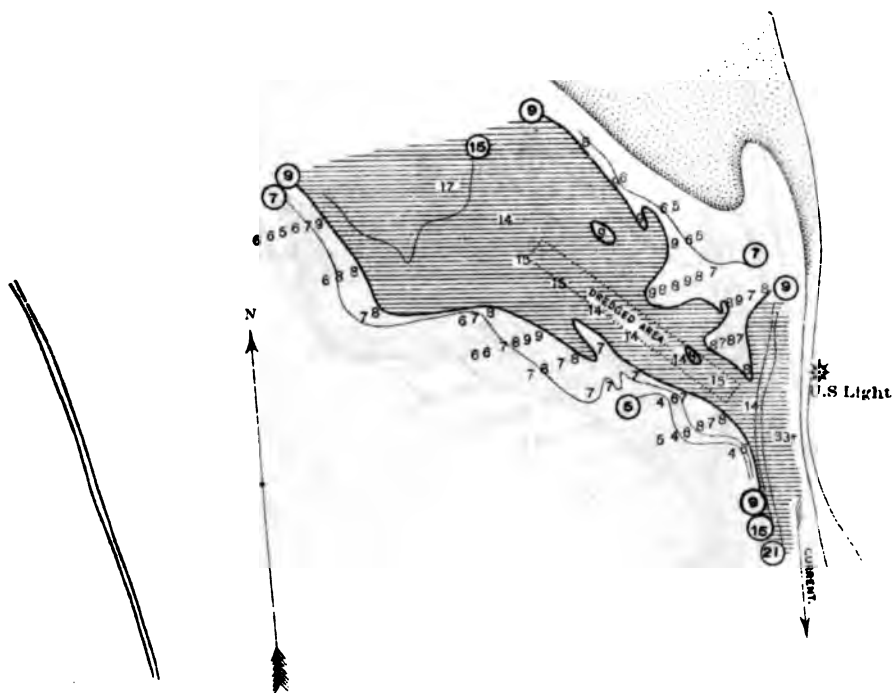
SCALE OF FEET.



Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 7.4 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water. **Eng 57 2**



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN Q. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18, 1901.

THREE DAYS AFTER DREDGING—SECOND TIME.

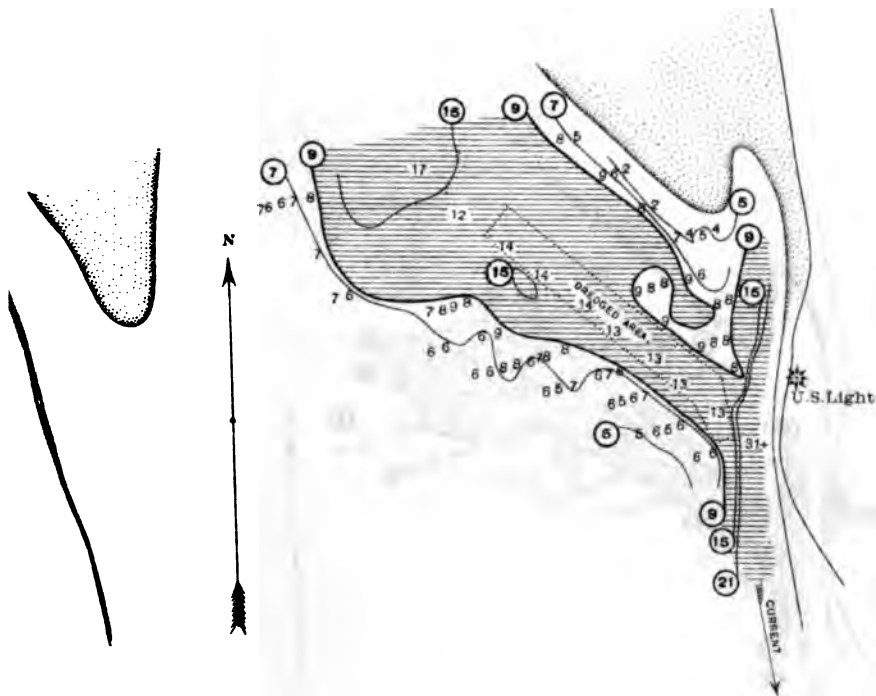
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 6.0 feet or 2.1 feet above mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



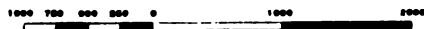
MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

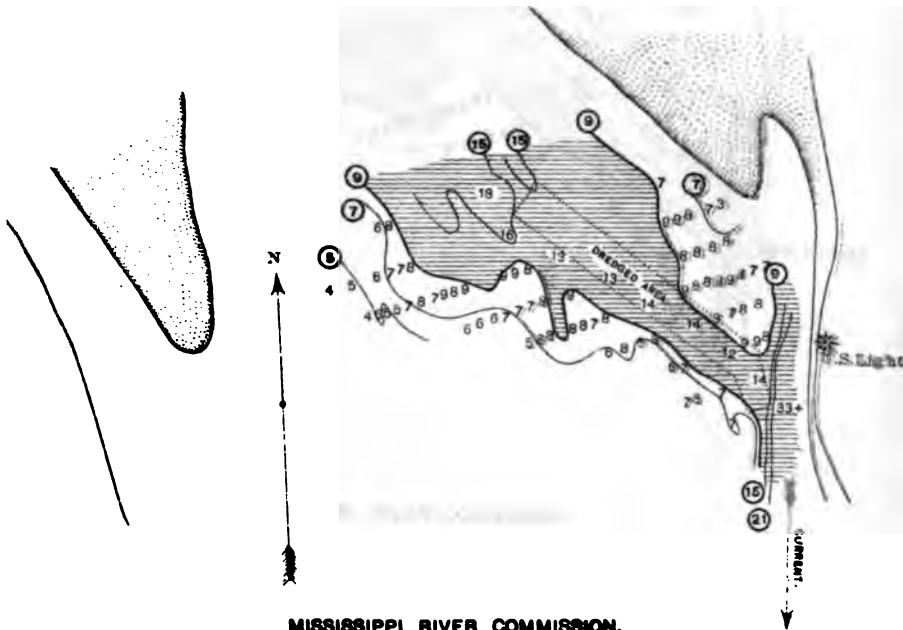
Survey of September 22, 1901.
SEVEN DAYS AFTER DREDGING—SECOND TIME.
SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 7.8 feet or 3.9 feet above mean low water.

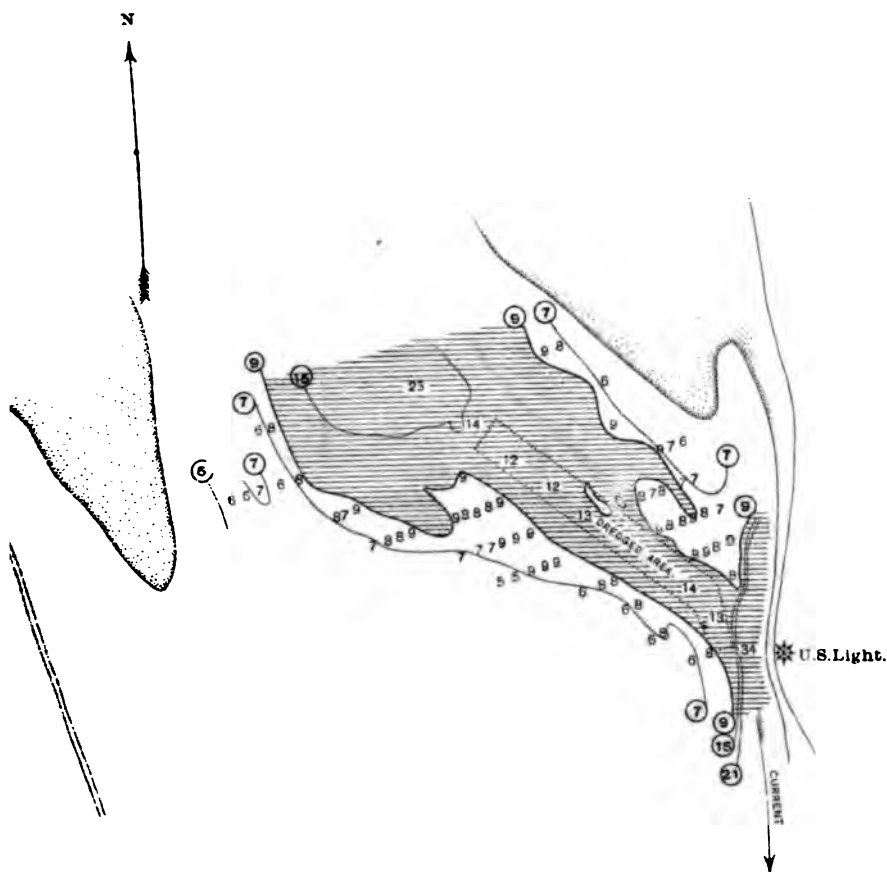
Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.
 MAP OF
 HATCHIE ISLAND CROSSING,
 Made under direction of
 CAPTAIN G. P. HOWELL,
 Corps of Engineers, U. S. A., Secretary.
 Survey of October 8, 1901.
 TWENTY DAYS AFTER DREDGING—SECOND TIME.
 SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 5.9 feet.
 Gage at time of survey was 6.2 feet or 2.3 feet above mean low water.
 Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 8, 1901.

THREE DAYS BEFORE DREDGING—THIRD TIME.

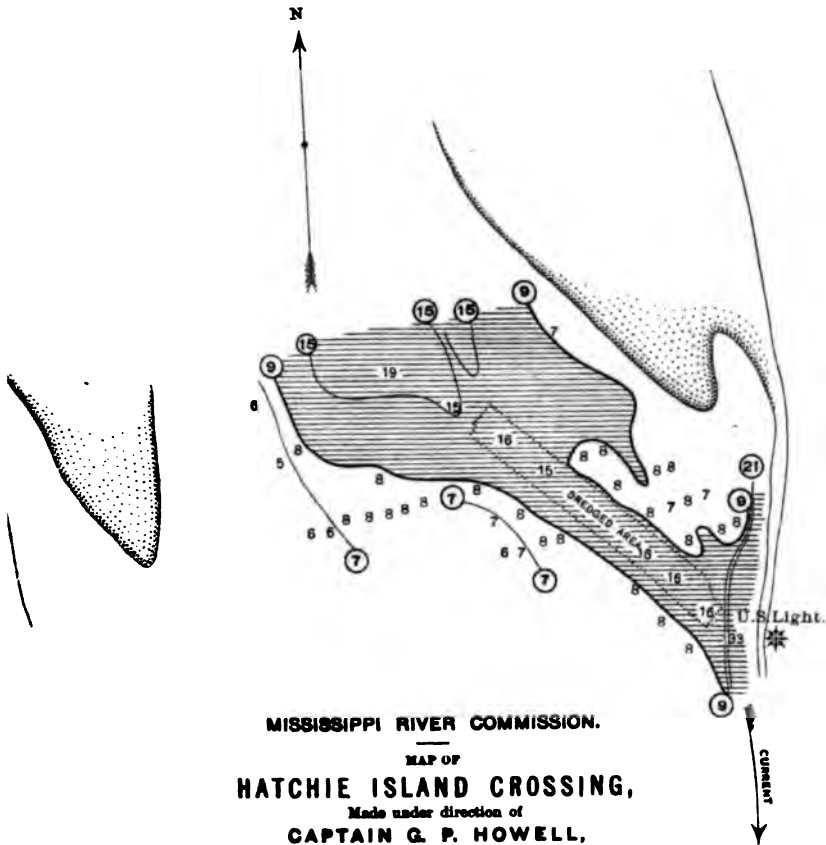
SCALE OF FEET.



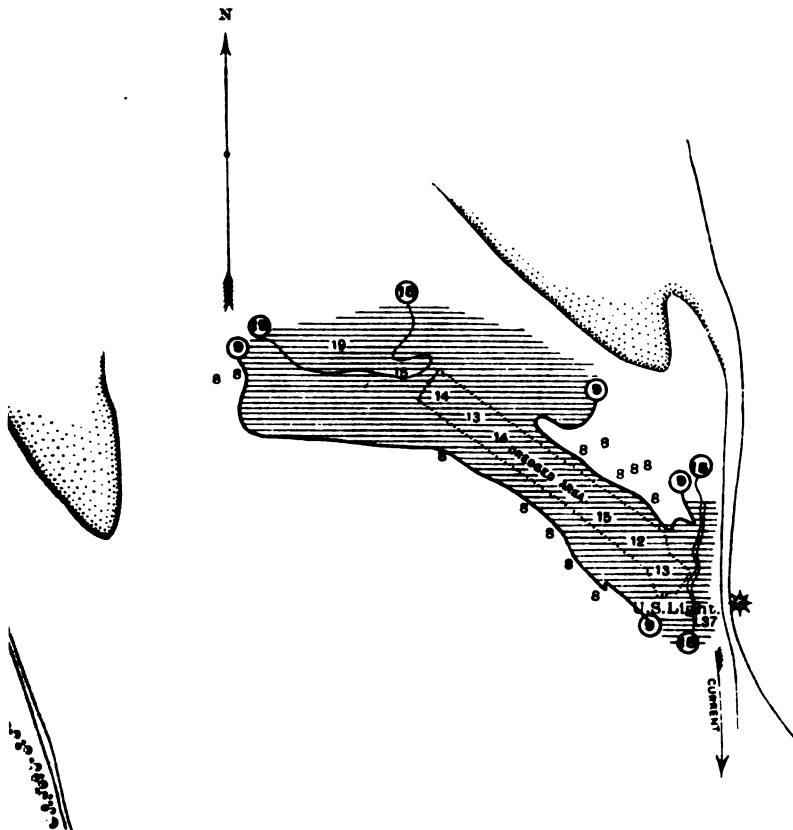
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 5.0 feet or 1.1 feet above mean low water.

Dotted areas indicate bars above mean low water. **Eng 57 2**



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.
Gage at time of survey was 4.9 feet or 1.0 foot above mean low water.
Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATCHIE ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1901.

THIRTY-FIVE DAYS AFTER DREDGING—THIRD TIME.

SCALE OF FEET.

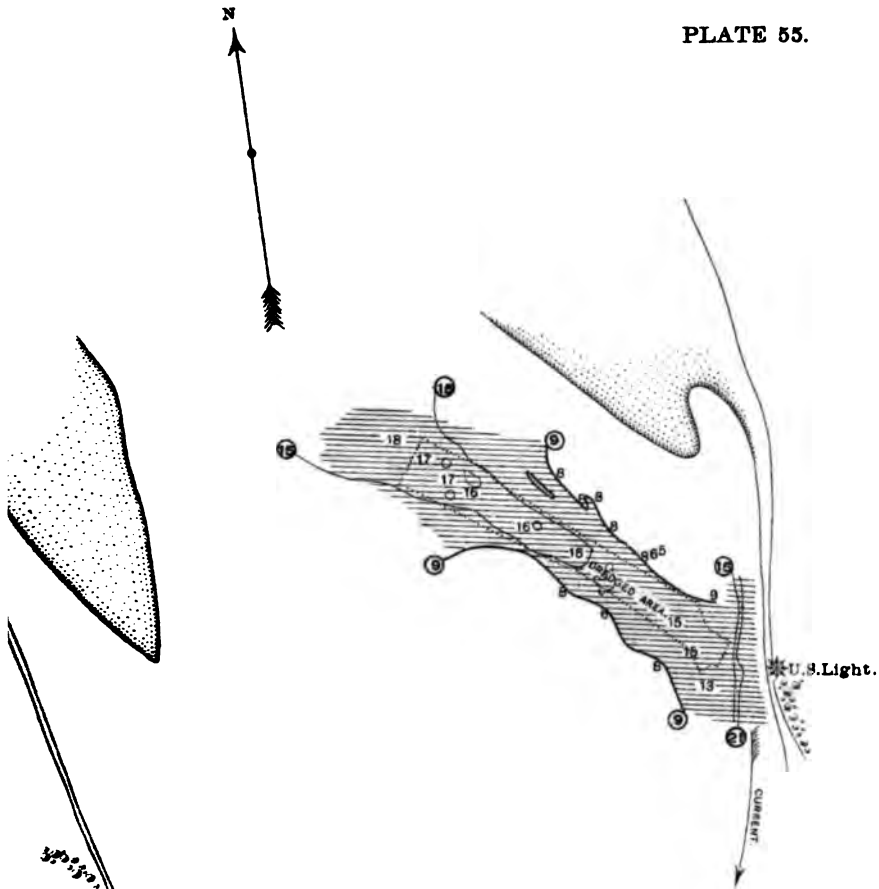


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 2.9 feet.

Gage at time of survey was 1.9 feet or 2.0 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.
 MAP OF
 HATCHIE ISLAND CROSSING,
 Made under direction of
 CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of December 1, 1901.
 ONE DAY AFTER DREDGING—FOURTH TIME.
 SCALE OF FEET.

1000 750 500 250 0 1000 2000
 1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 1.6 feet or 2.3 feet below mean low water.

Dotted areas indicate bars above mean low water.

MISSISSIPPI RIVER COMMISSION.
 MAP OF
 PRESIDENTS ISLAND CROSSING,

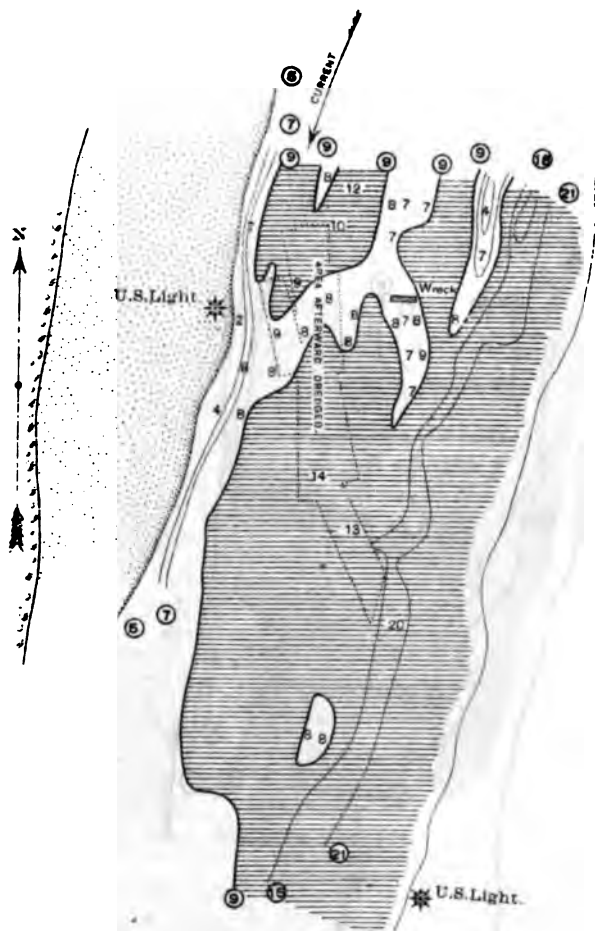
Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of August 12, 1901.
 ONE DAY BEFORE DREDGING—FIRST TIME.
 SCALE OF FEET.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 3.8 feet or 2.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

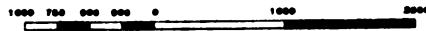


MISSISSIPPI RIVER COMMISSION.
 MAP OF
 PRESIDENTS ISLAND CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of September 9, 1901.
 DURING DREDGING—SNOOD TIME.

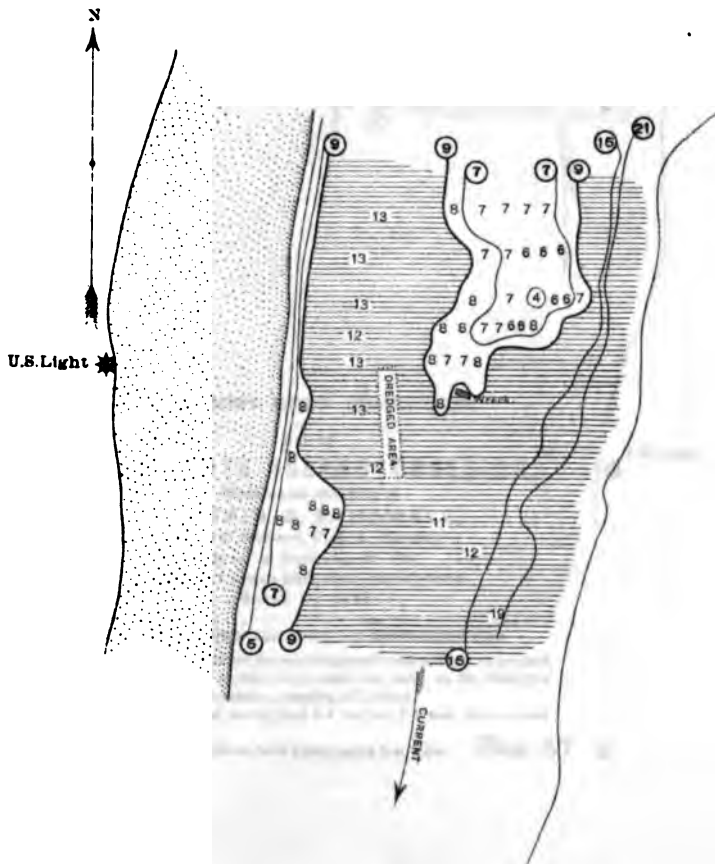
SCALE OF FEET.

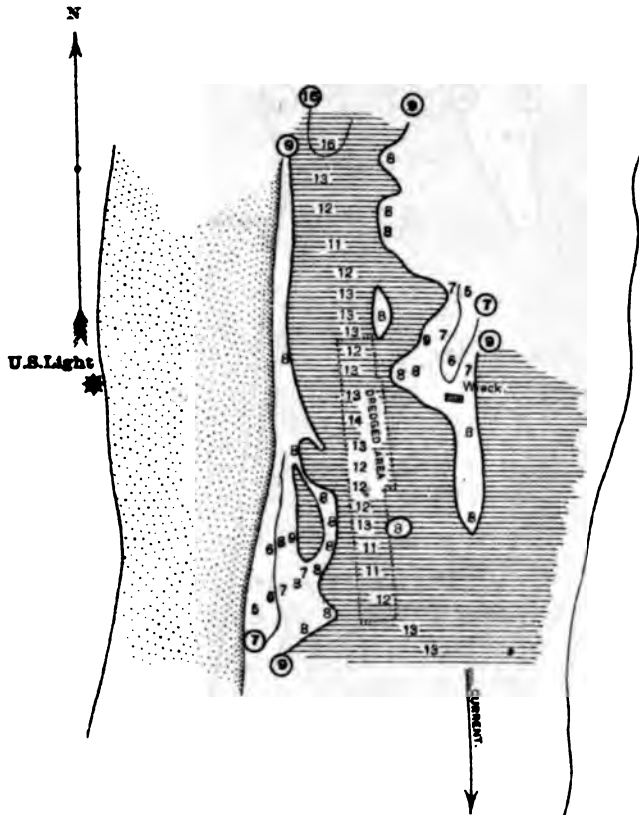


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 6.3 feet or 4.5 feet above mean low water.

Dotted areas indicate bars above mean low water.





MISSISSIPPI RIVER COMMISSION.
 MAP OF
 PRESIDENTS ISLAND CROSSING,

Made under direction of
 CAPTAIN G. P. HOWELL,
 Corps of Engineers, U. S. A., Secretary.

Survey of September 22, 1901.
 ONE DAY AFTER DRESSING—SECOND TIME.
 SCALE OF FEET.

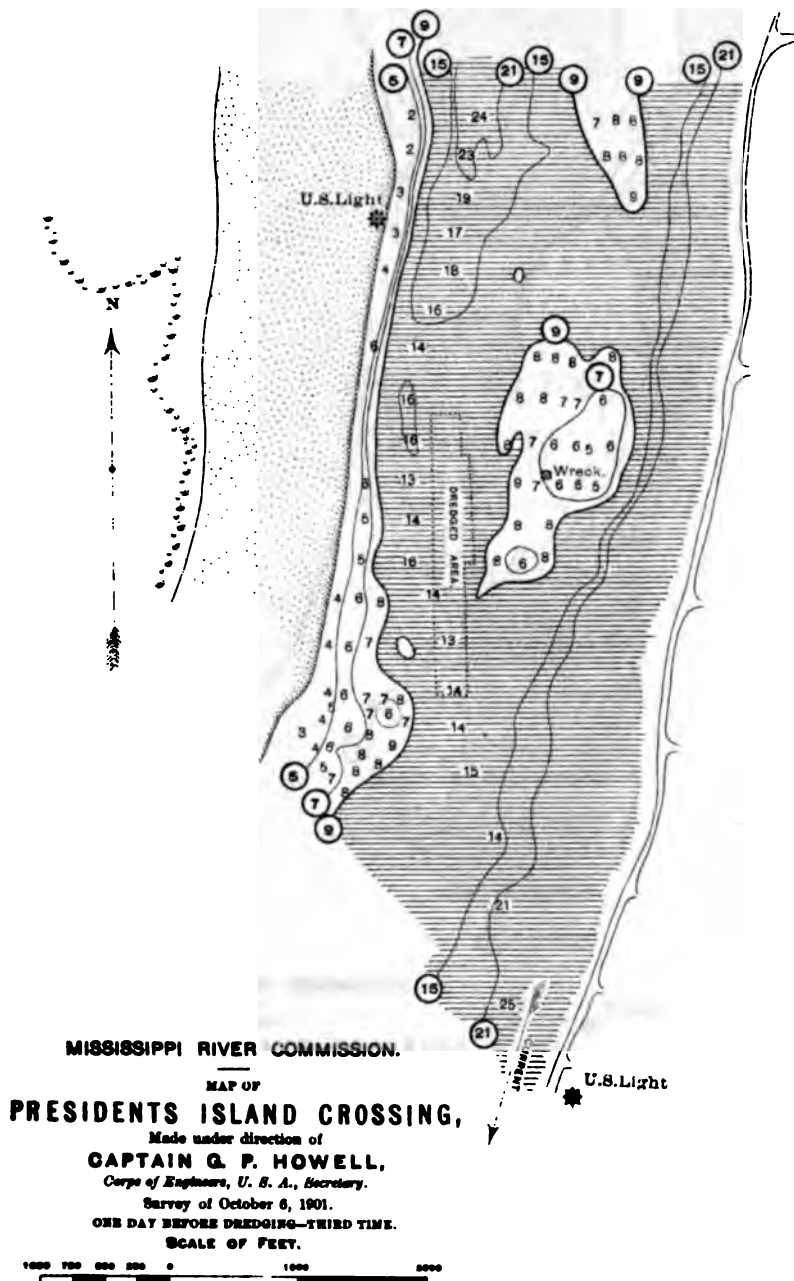


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.5 feet.

Gage at time of survey was 5.4 feet or 2.5 feet above mean low water.

Dotted areas indicate bars above mean low water. Ring 57 2

U.S. Light

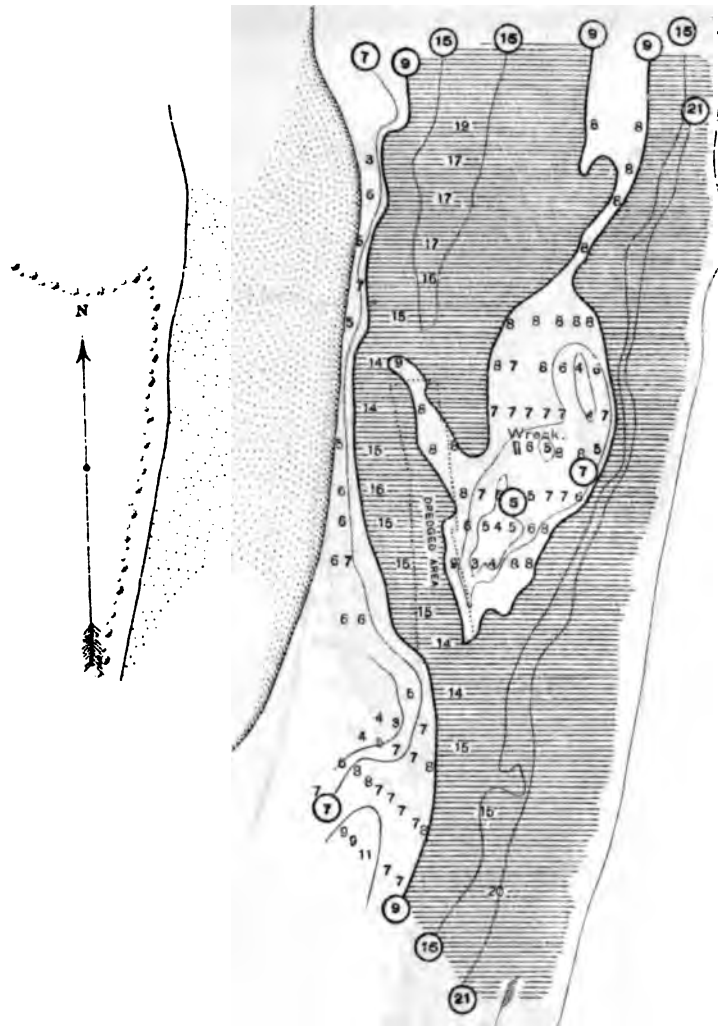


NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 3.8 feet or 2.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of October 22 and 23, 1901.

FIVE DAYS AFTER DREDGING—THIRD TIME.

SCALE OF FEET.



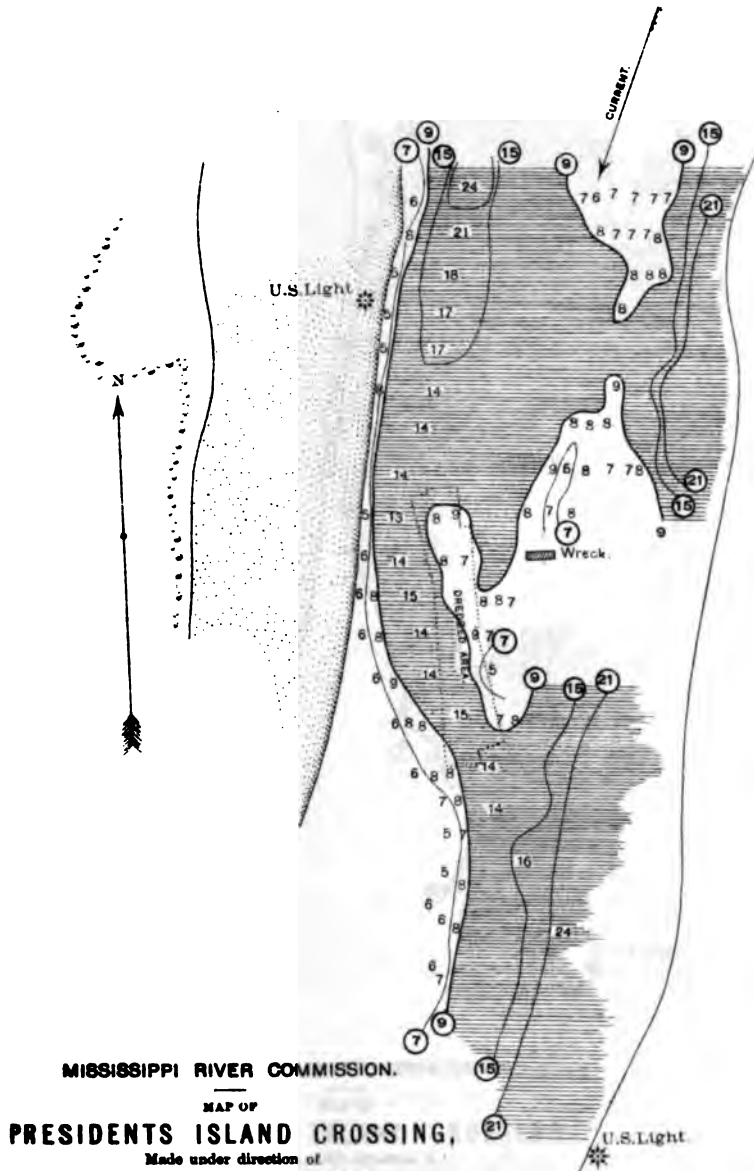
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 2.0 feet or 0.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2

PLA

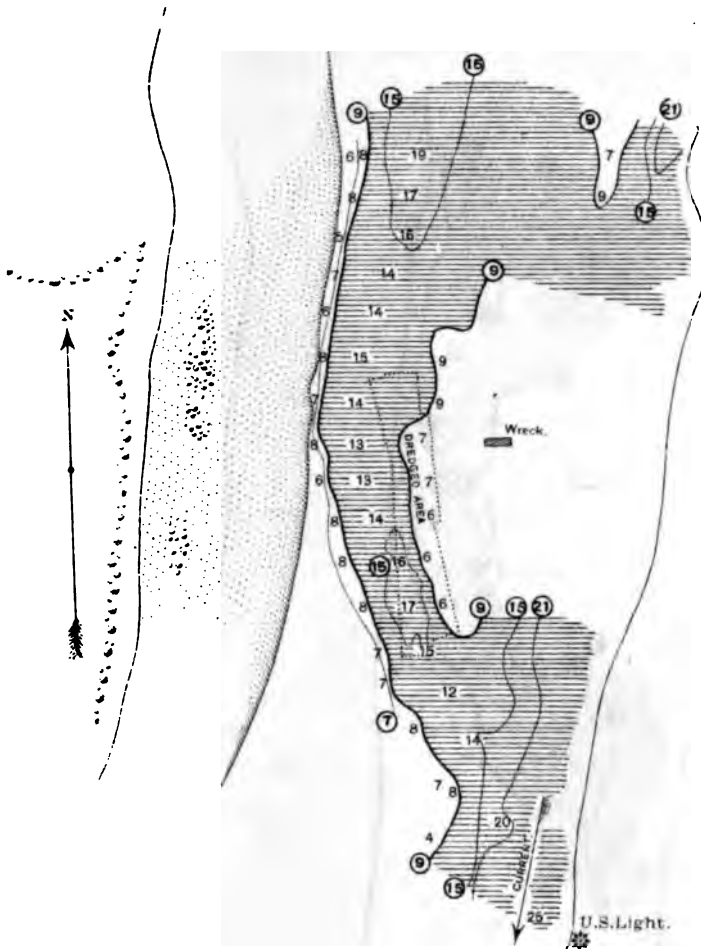


MISSISSIPPI RIVER COMMISSION.
 MAP OF
PRESIDENTS ISLAND CROSSING,
 Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.
 Survey of October 31, 1901.
 THIRTEEN DAYS AFTER DREDGING—THIRD TIME.
 SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.5 feet.

Gage at time of survey was 1.2 feet or 0.5 feet below mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2

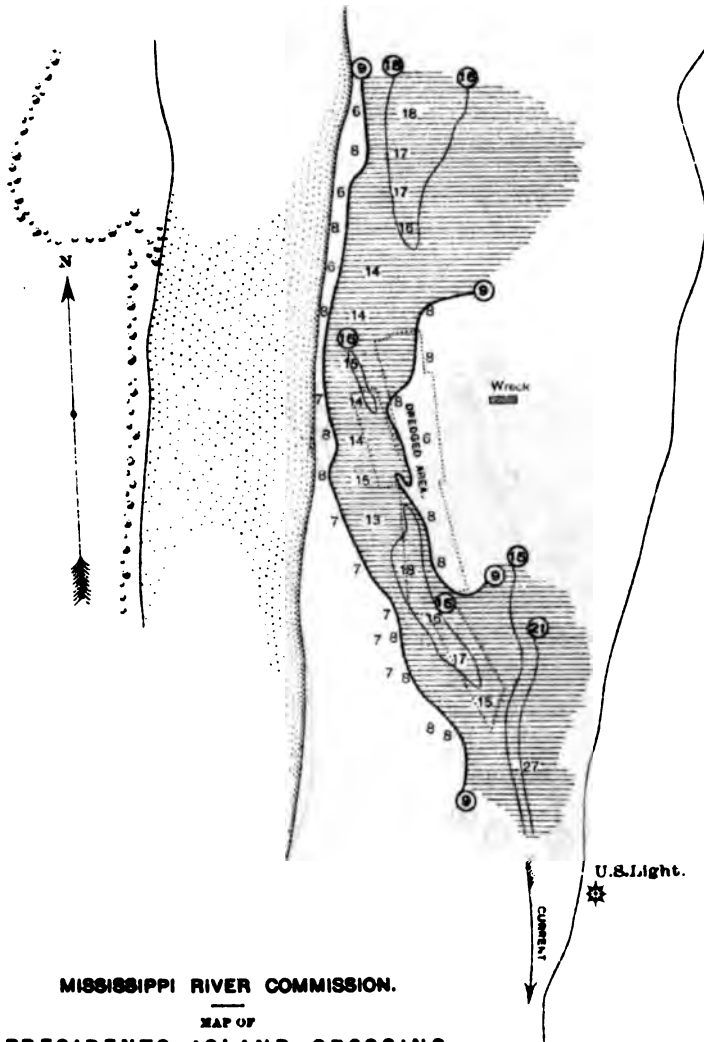


MISSISSIPPI RIVER COMMISSION.
 MAP OF
 PRESIDENTS ISLAND CROSSING,
 Made under direction of
 CAPTAIN G. P. HOWELL,
 Corps of Engineers, U. S. A., Secretary.
 Survey of November 16, 1901.
 ONE DAY BEFORE DREDGING—FOURTH TIME.
 SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 0.1 foot or 1.7 feet below mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN G. P. HOWELL,

Corps of Engineers, U. S. A., Secretary.

Survey of November 22, 1901.

ONE DAY AFTER DREDGING—FOURTH TIME.

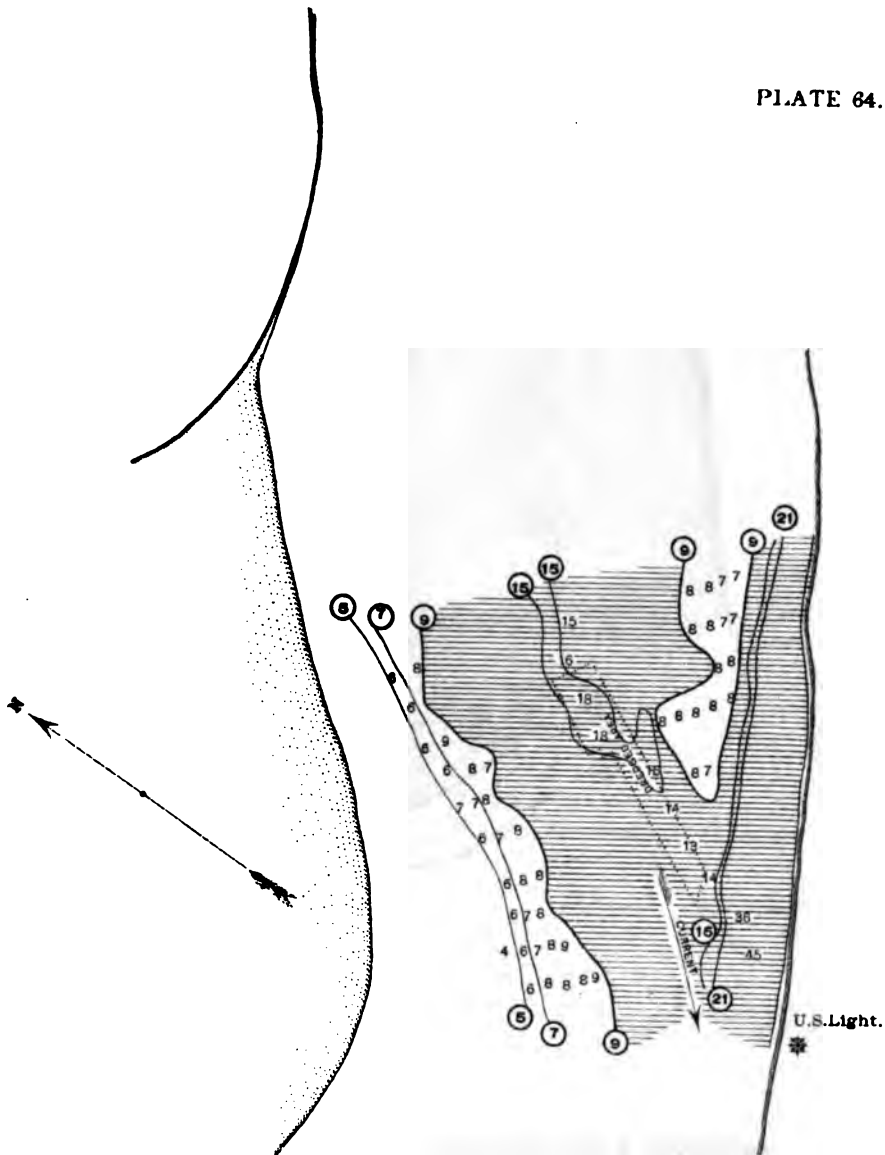
SCALE OF FEET.



Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.5 feet.

Gage at time of survey was 0.0 foot or 1.5 feet below mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2



MISSISSIPPI RIVER COMMISSION.

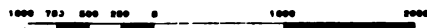
MAP OF

POLKS CROSSING,

Made under direction of
CAPTAIN G. P. HOWELL,
Corps of Engineers, U. S. A., Secretary.

Survey of October 30, 1901.
EIGHTEEN DAYS AFTER DEEDGING.

SCALE OF FEET.



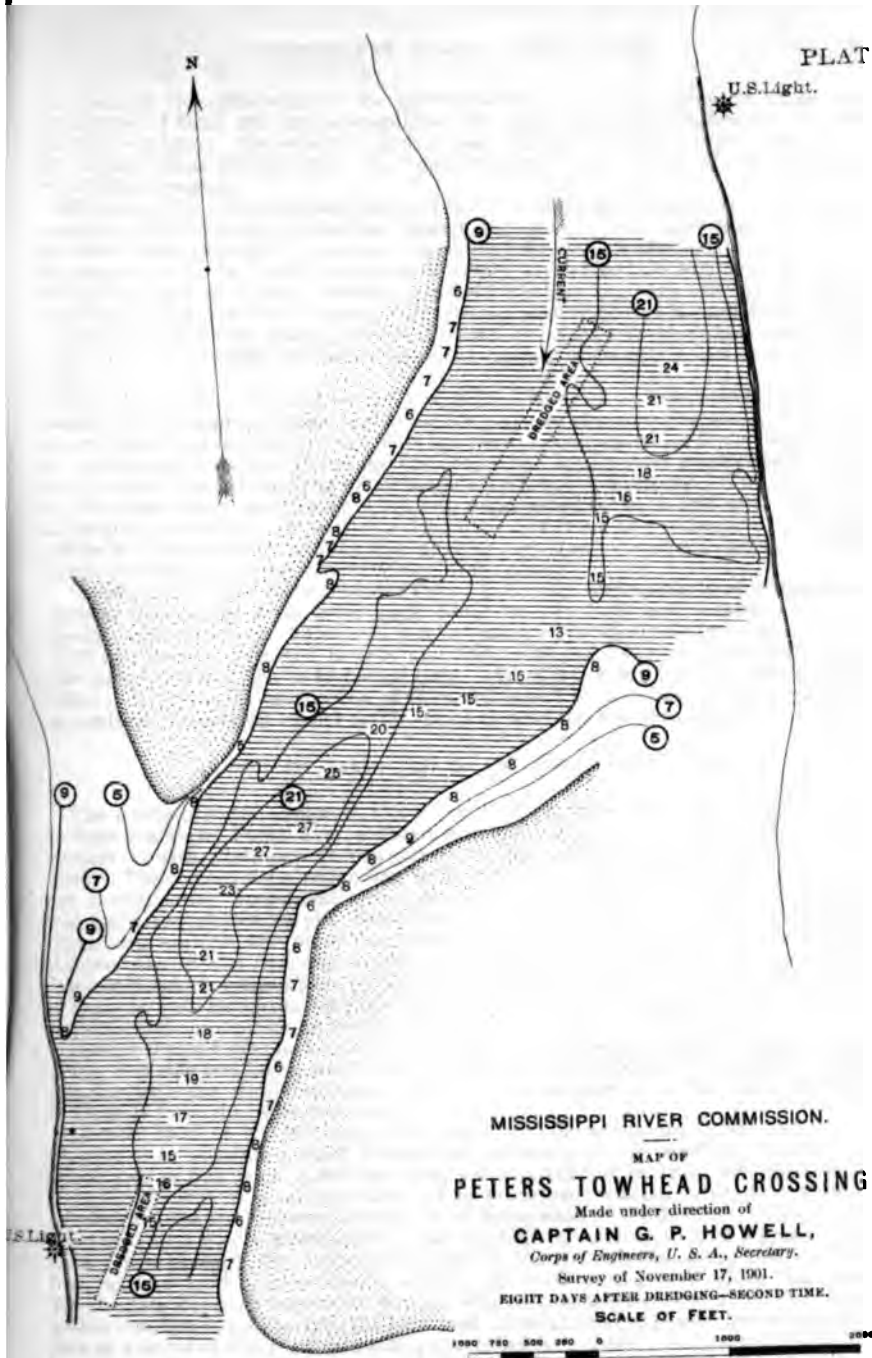
NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Moon's gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 1.8 feet or 0.8 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 57 2

U.S. Light.



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoons gage, which corresponds to a reading of 1.5 feet.

Gage at time of survey was -0.5 feet or 2.5 feet below mean low water.

Dotted areas indicate bars above mean low water. Eng 57 2

stopped by the exhaustion of the appropriation. This work protects about 2,200 linear feet of bank and has accomplished the object for which designed. It is still in fair condition. Some slight caving has occurred in recent years between the dikes and below dike 5, where the bank is unprotected, but no additional work is required at present.

Hickman, Ky. (36 miles below Cairo, L.).—The work at this locality is designed to prevent further caving of the river bank along the city front and has been carried on with funds provided by special appropriations and by allotments from general appropriations. In 1889 a mattress of brush and stone 930 feet long was placed along the bank in front of the city. In 1892 this was supplemented by paving the bank above low water with riprap. In 1894 the revetment was extended downstream a distance of 630 feet, making the total length of continuous revetment now in place 1,560 feet. This work has been repaired at various times and is now in good condition.

New Madrid, Mo. (71 miles below Cairo, R.).—The work at this point has been done under special appropriations and is for the purpose of preventing the caving of the river bank along the city front. This has been accomplished by the construction of a continuous revetment of the standard type, the fascine river mattresses being 250 feet or more in width and the upper bank being paved with riprap. The total length of this revetment is now about 4,500 feet, constructed between 1893 and 1899. It is all in good condition. This covers the entire city front and extends below it, and unless it is intended to continue this work as part of the systematic bank protection of the entire river, no further extension is necessary.

Caruthersville, Mo. (110 miles below Cairo, R.).—The work done here is intended to prevent the caving of the river bank along the city front and is carried on under special appropriations. There is now in place a standard continuous revetment 1,890 feet long, constructed in 1898 and 1899, with fascine river mats and a stone paving up to about the 16-foot stage only. All of it is now in fair condition, but in order to prevent the destruction of the work it will be necessary in the near future to continue the paving higher up the slope to near the top of the bank.

PLUM POINT REACH (147 TO 186 MILES BELOW CAIRO).

The works of improvement in this reach have extended from above Daniels Point to near Craighead Point, Ark., a distance of about 20 miles (151-171), and have been carried on with allotments from appropriations for the general improvement of the river. These operations, extending from 1882 to date, have been fully described in previous reports. In general terms, the work done has been the closure of Osceola and Bullarton chutes by pile dikes; the partial closure of Gold Dust Chute by pile dikes and a brush and stone dam; the contraction of the main river by dikes at Ashport Bar, Elmot Bar, and at Plum Point; the revetment of caving banks above Daniels Point, throughout Ashport and Fletchers bends, and along a part of the fronts of Osceola and Bullerton bars, at Plum Point, and near Craighead Point, and the construction of levees along both banks of the river.

During the past year no allotment for this work was made by the Commission, there being no funds available, and work was restricted to making such repairs as were possible with the available balance from former allotments to the revetment works at Daniels Point and Fletchers Bend.

Daniels Point, Ark. (152 R.).—The object of this revetment, 8,800 feet long at present, is to maintain a fixed direction of approach to the bend next below. The upper part of this work, 4,800 feet long, was constructed in 1895, with fascine river mats, and is still in good condition. The lower part was constructed in 1889 and rebuilt in 1892, the old-style woven mats being used in both years. This type of mattress proved to be insufficient in the rapid current met with at this place. Scour took place through the mats, which settled, leaving a break along the low-water line, and in 1895 narrow fascine connecting mats were placed along this break. These mats were too narrow to entirely stop the destructive action of the current which continued, and by 1899 the bank had been cut away at places, leaving the shore line as a series of sharp salients with pockets between them. In that and the following year the available funds not being sufficient for general repairs, the attempt was made to patch up the work by strengthening the salients and placing dikes as eddy breakers in the pockets. This work has been partially successful, but, as was expected, the destructive action has continued along the toes of the dikes and salients and between them. At the beginning of this low-water season it was found that both of the 1900 dikes had slid out into deeper water, and their repair was not possible with the funds available. The lower 1899 dike had been partially undermined on its downstream side, and the salient immediately below it had been partially cut

away on its upstream side. These two places were repaired by crib work and a small connecting mat, which repairs have successfully prevented further damage at these points during the recent high water.

The field cost of this work was \$1,653.73. (Further details will be found in the report of Assistant Engineer Nolty.)

The present condition of the revetment is as follows: The upper part of the work for a distance of 4,900 feet is all in good condition; then for 1,600 feet the bank work has been badly shattered and has been patched up in the last three years; then for 1,100 feet all is in good condition; then follows a pocket 700 feet long, now slowly filling up, and finally a stretch of 400 feet of the original work partially detached from the main bank but connected with it by a large dike built in 1899.

The past high water has continued the destructive action along the shattered part of this work and has extended the shattering both upstream and downstream into the good parts of the revetment, and it is now imperative, if this point is to be held and the shattered length be at once well and carefully repaired with full width fascine mats.

Fletchers Bend, Arkansas (158-161 R.).—The revetment of this bend, at present about 17,000 feet long, was constructed between 1884 and 1900. Work this season was confined to repairing a narrow fault at the low-water line along about 800 feet of the work constructed in 1888 and 1889. This fault was repaired by 815 linear feet of connecting mat from 25 to 50 feet wide, and by readjusting the upper bank work. The field cost of this work was \$4,146.48. (Further details will be found in the report of Assistant Engineer Nolty.)

The revetment of this bend is now in good condition except along about 1,200 feet of the 1884 and 1888 work, which has been badly damaged by the recent high water.

Other works.—The works in this reach other than those at Daniels Point and Fletchers Bend are now generally in an effective condition except as follows:

A slight fault in the Ashport Bend revetment.

The destruction of a part of the head of the Osceola Bar revetment of 1895. The bank above the head of this work has never been revetted and has caved quite rapidly in recent years, and in the last two seasons this caving has cut behind the 1895 revetment work and thus destroyed a part of it.

In Gold Dust Chute the gap in the dam has enlarged slightly, but no other material change seems to have taken place in the chute.

EXPERIMENTAL DIKES.

In 1898 the Commission decided to try to develop experimentally a light form of dike to be used on the Mississippi River to close secondary chutes and to aid in building up the banks of the main river. These dikes were to be built of so simple a form as not to be an obstruction to navigation should subsequent changes leave them in the channel of the river.

Dikes of this character have been built at Point Pleasant (80 L.), Cherokee (90 R.), Ashport Bar (158 R.), and Elmot Bar (160 L.), and were described in my last report (supplement to Report of Chief of Engineers, 1901, p. 235). The dikes at Point Pleasant were not successful, owing to a rapid change in the river above them, but at the other localities they have been very successful; they have caused a rapid growth of the bars on the side of the channel and have contracted and improved the crossings.

SECOND DISTRICT (FOOT OF ISLAND NO. 40 TO MOUTH OF WHITE RIVER, 175 MILES).

Hopefield Bend, Arkansas (227-230 miles below Cairo, R.).—The revetment in this bend, now about 16,600 feet long, extends from Mound City Landing to about 500 feet below Hopefield Point, and has been constructed from funds allotted by the Commission from appropriations for the general improvement of the river. (The locality is shown on the map of Memphis and vicinity accompanying this report.)

The object of this revetment is to prevent the further caving of this bend and the consequent growth of the opposite bank and the encroachment of the sand bar upon the wharf front of Memphis. Work was begun in 1882 and was continued, except when stopped by high water, until 1884, 9,600 feet of bank being revetted, of which, however, 1,500 feet at the lower end were destroyed before a further extension of the revetment was made. In 1887 this work was extended downstream 4,000 feet, and in 1888 the work was further extended to Hopefield Point. When work was started it was hoped to hold the bank about in the position it occupied at that time, but the failure of appropriations at critical times prevented this, and before the revetment reached Hopefield Point the bank by caving had receded at that point more than 3,000 feet. Repairs have been necessary from time to time both to the subaqueous work and to the bank above the paving. All mattress work done prior to 1893 was

of the old-style woven type, and since that time this older mattress has been covered by the more modern fascine mattress along about the lower 6,000 feet of this work.

No new allotment was made for this work this season, but with a small balance left from the previous year slight repairs have been made, two small dikes being built and some stone being added to the pavement.

At one point in the revetment an old break that had made a pocket in the bank had been revetted. During high water there has been formed in this pocket an eddy so violent as to do each year more or less damage. To break up this eddy there was constructed this season in the centre of the pocket a small dike.

Around the point at the lower end of the revetment there has been formed in high water another eddy which has, by cutting behind the revetment, destroyed part of it. To check this a small dike was built in 1900. This was quite successful, and this year there was added another small one just below the former one. These two dikes have been very successful, and there was during the recent high water quite a large deposit in and around them.

The repairs to the paving consisted in adding stone at those places exposed at the very low stages of the season that seemed to require it.

The total field cost of this work was \$2,763.78. (Further details will be found in the report of Assistant Engineer Rees.)

The revetment is now in good condition, but as it is absolutely necessary for the existence of the present Memphis wharf front that Hopefield Point should not be allowed to recede farther, this revetment must be carefully watched and repaired from time to time as may be necessary.

Wolf River (230 miles below Cairo, L.).—This work is carried on by special appropriations and its object is to keep the channel of this river navigable during the low-water season as far as the county bridge, about 2½ miles above the mouth of the river. The channel of this river for the lower 2,000 feet is through the Memphis sand bar.

The first appropriation for this river was made in 1896. The approved project provided for dredging and the removal of sunken logs, snags, and other obstructions. An attempt was made to have this dredging done by contract, but during the progress of the work so many unexpected difficulties presented themselves that justice to the contractor required the termination of the contract, which was done May, 1898, after about 30,000 cubic yards of material had been removed.

In July, 1898, a dipper dredge was purchased for use on this work, and operations have since been carried on by hired labor. At first the material dredged was deposited on the banks, but later dredging in recently deposited material developed a tendency of this soft mud to slip back into the channel, and to avoid this it was decided to use scows and transport the dredged material to deep water.

The work this season was carried on with an unexpended balance pertaining to Memphis Harbor, of which this river forms a part. Work began July 23 and was continued, with some interruptions, until December 16, 51,060 cubic yards of material being removed. The total cost of this dredging, including surveys, office expenses, superintendence, etc., was about 12.61 cents per cubic yard. (Further details will be found in the report of Assistant Engineer Rees.)

The season's work was very successful, the river being kept open for the boats using it, and no interruption being caused to the mills, which are dependent for their supply of logs upon the navigation of Wolf River. Although the river reached a considerably lower stage this season than in the year preceding, better navigable depths were maintained in Wolf River and for a longer stretch of the river than ever before, thus showing a progressive improvement of the channel; but dredging will be necessary each year, as at each high water of the Mississippi there will be a deposit of sediment in Wolf River which must be removed.

Memphis Harbor (230–232 miles below Cairo, L.).—The work at this point is the protection of about 14,800 linear feet of bank. It has been done by special appropriations, by allotments from the appropriations for the general improvement of the river, by funds raised by the citizens of Memphis, and by the bridge company. All of this work is of the continuous type except the 2,200 feet protected by the citizens' dikes. The paved levee of the city extends from Jefferson street (4,700 feet below the head of the revetment) to Beale street, a distance of about 2,800 feet. This revetment work is now in good condition, but the city front from Wolf River down to Monroe street is obstructed by a large sand bar that has formed as the result of the caving away of Hopefield Point. In its present condition the bar makes about half of the paved levee inaccessible to steamboats except at high stages. This bar, though increasing in height, does not seem to be extending downstream, and to prevent such an extension, which would be ruinous to the existing wharf front, it is essential that Hopefield Point be not allowed to recede further.

Helena Harbor (306 miles below Cairo, R.).—The work at this point has been done under special appropriations, and consists of the protection of the bank for a length of 4,900 feet to prevent its erosion and the encroachment of the river upon the town. The revetment is of the continuous type from the head of the work to Dike 1, a distance of 1,140 feet. Thence for 1,180 feet to Dike 4 the revetment consists of the dikes built in 1889 and repaired frequently since. Floor mattresses have been built in all the intervals except one, so that below water the work is continuous except for an interval of 230 feet. Below Dike 4 the work consists of the standard type of continuous revetment for a distance of 2,580 feet, with the addition of crib dikes across a depression in the upper bank.

This revetment work is now in a generally good condition, but there has been in the last year a slight settlement of the bank in one or two places, causing some damage to the revetment that should be repaired in the near future.

GENERAL REMARKS UPON CHANNEL WORK DURING THE SEASON.

Owing to the failure of the last river and harbor bill and the consequent absence of funds, operations in these districts have been confined to slight repairs to the existing works at the places where these repairs were most urgently needed.

LEVEES.

Upper St. Francis levee district (from opposite to 70 miles below Cairo, R.).—This district extends from "the railroad embankment at the lower line of the town of Birdpoint, Mo.," to New Madrid, Mo., a distance by river of about 70 miles. The length of levee line when completed will probably be about 54 miles. This levee is to be continuous with the State levee, which, when completed, will extend up to Commerce, Mo., a distance by river of 35 miles. The area to be protected by these levees is the land between the river and Prairie Ridge, which is cut by the river at New Madrid. This area is about 700 square miles. This land, though generally low, is separated into sections by ridges which are above all except the highest overflows. The levee built to protect the above area also in a measure protects the Lower St. Francis Basin, which is subject to overflow by the flood water passing through the low gap at the upper end of Prairie Ridge. This latter region is also subject to overflow by high water getting through the narrow gap between Cape Girardeau and Commerce Ridge, but a small State levee has been built across this gap.

Between Commerce and Birdpoint a part only of the distance has been leveed, and the levee, which was built by State and local authorities, is still deficient in height and cross section. It ends at the Iron Mountain Railroad above Birdpoint, and between it and the new levee below that town there is at present an unleveed interval of about a mile. These two levees are, however, connected by the railroad embankment, which is above all except the highest floods, and negotiations are now in progress between the local authorities and the railroad looking to the closing of this gap in the levee line.

From Birdpoint southward a levee was started in 1896 by local authorities, but owing to financial difficulties, work was soon stopped. This incomplete levee was seriously damaged by the flood of 1897, and no work has since been done on the levee by the local authorities. About 98,700 cubic yards of this levee have been incorporated in the new levee under construction by the United States.

Work in this levee district by the United States has been carried on under allotments from the general funds at the disposal of the Commission. About 5½ miles of levee are now completed to the Commission's standard grade and cross section.

Between May 1, 1901, and April 30, 1902, no levee work has been done in this district, either by the United States or by local authorities.

The following is a summary of the earth in the levees of the district:

Levees in place April 30, 1902:	Cubic yards.
Erected by the United States.....	287, 198
Erected by local authorities.....	98, 700
Total.....	385, 898

This levee, as now completed, begins at the Cotton Belt Railroad embankment at the southeast edge of the town of Birdpoint, makes a loop around the large hole washed out in 1897, and thence follows the line of the old levee, all being completed to the standard Mississippi River Commission levee grade. Its present length is 5 miles and 2,000 feet. From this point southward the levee line has been surveyed by the local authorities as far as the Mississippi-New Madrid County line. According to this survey, this part of the levee will be about 35 miles in length, will contain

about 3,076,650 cubic yards of earth, and is estimated to cost about \$461,500. From the county line to St. John Bayou, at New Madrid, the distance by the levee line will be about 14 miles. This part of the levee line has not been surveyed, but it is estimated that it will require about 2,000,000 cubic yards of earth and will cost about \$400,000. There are therefore still required about 5,076,650 cubic yards of earth to complete the levees of this district, at an estimated cost of \$861,500. This estimate is in addition to the work required above Birdpoint, that part of this levee not being within the jurisdiction of the Commission.

Reelfoot levee district (36 to 60 miles below Cairo, L.).—This district extends from the bluffs at the city of Hickman, Ky., to the high land near Slough Landing, Tenn., a distance by river of 24 miles. The length of the levee when completed will be about 20 miles. The area that will be protected by this levee includes the entire bottom of Reelfoot Lake, extending from that portion of Prairie Ridge that lies south of the Mississippi to the bluffs on the east, an area of about 310 square miles. This area is drained into Obion River, which empties into the Mississippi about 100 miles below Hickman.

No appropriation or allotment for levee work has yet been made by the United States, but in accordance with the river and harbor act of June 6, 1900, the line of the levee was surveyed in July and August of that year. The total amount of levee work necessary to complete the levee was estimated at 2,457,187 cubic yards and the cost at \$400,000.

In September, 1900, the levee commissioners of Lake County, Tenn., contracted for the construction of all the levee that was to be in Tennessee. This work was completed in February, 1902. From May 1, 1901, to April 30, 1902, they did 440,710 cubic yards of levee work at a contract price of 13.99 cents per cubic yard. Up to date the entire expenses of the levee board, including levee work, superintendence, surveys, right of way, contingencies, etc., have been \$90,414.41.

A levee board has recently been formed in Kentucky, but has not yet done any levee work.

Four and one-half miles of this levee are now constructed to full Mississippi River Commission grade and cross section. The actual contents of the levee at present are 455,414 cubic yards, leaving about 1,850,000 cubic yards of levee work still to be done. The cost of this work, including right of way, superintendence, contingencies, etc., is estimated at \$275,000.

Lower St. Francis levee district (79 to 298 miles below Cairo, R.).—This district extends from the high lands about 9 miles below New Madrid to the mouth of the St. Francis River. Its length by river is 219 miles. The length by levee line when completed will probably be about 210 miles. The area that will be protected by the completed levee will be about 3,500 square miles.

The total length of levee already built is about 183 miles, divided into two sections by an unleveed interval of about 17 miles. The upper section is 166 miles long, beginning 1 mile above Point Pleasant, Mo. (79 R.), and ending near the head of Cat Island, Arkansas (253 R.). The lower section is 17 miles long, beginning at Holtree Bayou, back of Council Bend (268 R.), and ending near Walnut Bend Landing, Arkansas (282 R.). The lower end of this levee has been destroyed by the caving bank, and about 1 mile of it must be abandoned when an extension is made.

On May 1, 1901, two pieces of levee work under contract had not been completed. Work on these was continued during the year, and both were satisfactorily completed by December 1.

No allotment has been made for this district during the year, but in November the Commission directed that a portion of the high-water emergency fund of the district be used in building a loop around a point in the levee threatened by a caving bank near Thompsons Landing, Arkansas (195 R.). Work on this loop was begun in December and finished in February. Its length is 4,584 feet.

The levee work done between May 1, 1901, and April 30, 1902, consisted of "enlargement" work and the construction of one new loop levee, and is all shown in the following table, the quantities there given including all kinds of levee work, embankment, banquettes, excavations, etc.

Station.	Below Cairo.	Completed.	Price.	Remarks.
	<i>Miles.</i>	<i>Cu. yards.</i>	<i>Cents.</i>	
From 56/0 to 62/0.....	145	29,356.6	23.50	9,725.9 cubic yards in addition done during preceding year.
From 82/44 to 87/26.....	175	15,147.0	12.50	72,161.3 cubic yards in addition done during preceding year.
Loop at 109/0.....	195	29,823.6	12.24	

Total levee work done, 74,327.2 cubic yards, at an average contract price of 16.74 cents per cubic yard. All the above levee work was constructed to an elevation about 2 feet below the established Mississippi River Commission levee grade.

The total cost of this work to the United States was \$17,072.88. This includes office expenses, superintendence, surveys, engineering expenses, contingencies, but excludes \$9,068.67 earned by the contractors during the previous season and paid to them during this year. The average cost, including the above items, was 22.97 cents per cubic yard of levee work.

In addition to the above work by the United States, the St. Francis Levee Board of the State of Arkansas built about 12 miles of new levee from station 161/0 to station 173/0 (245-253 R.), to a grade about 3 feet below the standard adopted by the Commission, and repaired the levee on mile sections 100, 141, and 194. They did 864,166.3 cubic yards of levee work at an average cost of 16.97 cents per cubic yard. Their expenses for all purposes, including right of way, drainage, office expenses, surveys and contingencies, during the period covered by this report, were \$213,425.43.

The only work done by the St. Francis Levee Board of the State of Missouri was to build a short loop levee, 1,185 feet long, across a salient of the old levee threatened by the caving bank about 2 miles below Caruthersville, Mo. (111 R.). This new loop contains 16,200 cubic yards of earth and cost \$4,158. The total expenses of the board during the year were \$4,758.

During the period from May 1, 1901, to April 30, 1902, earth was added to the levee as follows:

	Cubic yards.
By the United States	73, 476
By local levee boards and others	758, 490
Total	831, 966

During this period there were lost or abandoned on account of caving banks the following portions of the levee, which were constructed in part by the United States and in part by the levee boards:

Stations.	Below Cairo.	Length.	Amount.	Put up by United States.	Put up by levee boards.
	<i>Miles.</i>	<i>Feet.</i>	<i>Cu. yards.</i>	<i>Cu. yards.</i>	<i>Cu. yards.</i>
29/31 + 85 to 29/44 + 75	111	1, 290	18, 150	9, 825	8, 325
108/34 + 25 to 109/25 + 50	195	4, 405	20, 680	.....	20, 680
F./35 + 66 to G./3 + 70	284	2, 034	66, 360	66, 360	.....

The following is a summary of the earth in the levees of this district:

	Cubic yards.
Put up by the United States and in place April 30, 1901	4, 411, 576
Added from May 1, 1901, to April 30, 1902	73, 476
Total	4, 485, 052
Lost or abandoned during the year	76, 185
In place April 30, 1902	4, 408, 867
Put up by levee boards and others and in place April 30, 1901	8, 859, 329
Added from May 1, 1901, to April 30, 1902	758, 490
Total	9, 617, 819
Lost or abandoned during the year	29, 005
In place April 30, 1902	9, 588, 814
Levees in place April 30, 1902:	
Erected by the United States	4, 408, 867
Erected by local authorities	9, 588, 814
Total	13, 997, 681

The existing levees in this district are generally in good condition. The portion built previous to the 1897 flood has been greatly strengthened, and the new levees built since have been constructed to a height considerably above that flood line and with a substantial cross section. Practically all has been completed to an elevation

about 2 or 3 feet below the established Mississippi River Commission grade and about 6 miles to that grade, but a large amount of banquette work is needed to complete the levee to the standard cross section. In several places the levee is threatened by caving banks, and around such places new loops must be constructed.

As stated above, the levee is divided into two sections by an unveeved interval of about 17 miles. The lower stretch of levee is intact, but in the upper stretch there is a gap 600 feet long on the loop back of the town of Point Pleasant (80 R.). This is owing to the failure of the local authorities to provide the necessary right of way. The United States had made a contract for the construction of this entire loop, but owing to the neglect of the levee board to purchase the right of way for this 600 feet, that length was not built.

To completely close in the Lower St. Francis levee district, and to finish the existing levee to the Commission's standard grade and cross section will require about 10,500,000 cubic yards of earthwork, divided as follows:

To complete the upper section of existing levee, Point Pleasant to near Cat Island (165 miles).....	5,500,000
To close the gap between two sections (18 miles).....	2,000,000
To complete lower section of existing levees (17 miles).....	1,000,000
To extend levee to mouth of St. Francis River (10 miles).....	2,000,000

This will probably cost about \$1,680,000. This does not include the as yet undetermined cost of new loop levees.

White River levee district (306 to 385 miles below Cairo, R.).—The length of this district by river is 79 miles, and by the levee line 74 miles. The levee starts at the foot of Crowley's ridge, at the upper end of the city of Helena, and the terminus is at the end of the back line of the Laconia Circle levee. The United States has control of 64 miles of the levee, the remaining 10 miles of levee being maintained and controlled by the local boards, 8 of these miles consisting of the back line of the Laconia Circle, and the other 2 being in front of the city of Helena. The territory to be protected is a narrow strip of from 8 to 30 miles in width, lying between the Mississippi and White rivers, and having an area of about 910 square miles. Four breaks exist at present in this line, all made by the flood of 1897. The total length of the existing breaks is about 10,000 feet, and all are situated within a distance of 6 miles, near Modoc and Hugheys (335 to 341 R.).

At the date of the last annual report one levee contract was in force, upon which work had not been begun, with Z. T. Anderson for enlargement work in Old Town Bend (321 R.). This contract was satisfactorily completed in December.

No allotment for levee work in this district was made by the Commission during this year.

The levee work done between May 1, 1901, and April 30, 1902, was all enlargement work, and is shown in the following table, the quantities there given including all kinds of levee work, embankment, banquette, excavations, etc.:

Station.	Below Cairo.	Com- pleted.	Price.
	Miles.	Cu. yards.	Cents.
From 15/32 to 16/10.....	321	37,815.4	24.25

Total levee work done, 37,815.4 cubic yards, at an average contract price of 24.25 cents per cubic yard.

The United States expended in this district for levee construction between May 1, 1901, and April 30, 1902, the sum of \$11,491.44. This includes office expenses, superintendence, surveys, engineering expenses, and contingencies. The average cost per cubic yard of levee work, including the above items, was 30.39 cents.

During the year the local levee authorities have repaired and enlarged the levee on mile sections 2, 9, 10, 18, 19, 24, 25, 50, 51, and 52. They have added to the levee 110,711 cubic yards of earth, at an average contract cost of 19.39 cents per cubic yard. Their total expenditure, including levee work, superintendence, surveys, office expenses, right of way, and contingencies, was \$22,822.24.

During the period from May 1, 1901, to April 30, 1902, earth was added to the levee as follows:

	Cubic yards.
By the United States	36,777
By local levee boards and others	110,711

Total..... 147,488

None of the existing levee was lost or abandoned during the season on account of caving banks or from other causes.

The following is a summary of the earth in the levees of this district:

	Cubic yards.
Put up by the United States and in place April 30, 1901	6,048,707
Added from May 1, 1901, to April 30, 1902.....	36,777
Total.....	6,085,484
Put up by levee boards and others and in place April 30, 1901.....	1,342,023
Added from May 1, 1901, to April 30, 1902.....	110,711
Total.....	1,452,734
Levees in place April 30, 1902:	
Erected by United States	6,085,484
Erected by local authorities.....	1,452,734
Total.....	7,538,218

The levee in this district is generally low and weak; some of it is still below the high water of 1897; much consists of an old levee of good cross section, but of insufficient height, upon which has been placed a topping with steep slopes and a narrow crown. There are at present, as stated above, four breaks in the system, with a total length of about 10,000 feet. To close these gaps and construct the levee to the Commission's standard grade and cross section will require about 8,800,000 cubic yards. Besides this, the levee for about the 4 miles above Beiths Landing (367 R.) is in serious danger of caving into the river, and it will be advisable, instead of raising and enlarging the existing levee, to build a new levee back of the present one, which will increase the above estimate by 300,000 cubic yards, making a total yardage required to complete the present levee system of 9,100,000, which is estimated to cost about \$1,820,000, including engineering expenses and other contingencies. The above estimate does not include any work on the back levee of the Laconia Circle, which is considered a private levee and not part of the regular system.

Upper Yazoo levee district (244 to 365 miles below Cairo, L.).—The length of this district by river is 121 miles, and the length of the levee line 124 miles. The levee begins at the foot of the bluffs, about 14 miles below Memphis, and extends to the Coahoma-Bolivar county line, the southern boundary of the district. It is continuous with the Lower Yazoo levee below that county line. The territory protected by the levee is about 3,281 square miles.

On May 1, 1901, one levee contract had not been completed. The contract time had expired and the work was finished by the United States in November.

No allotment for this levee district was made by the Commission during the year.

The levee work done between May 1, 1901, and April 30, 1902, was all enlargement work, and is shown in the following table, the quantities there given including all kinds of levee work, embankment, banquettes, excavations, etc.:

Station.	Below Cairo.	Completed.	Price.
	<i>Miles.</i>	<i>Cu. yards.</i>	<i>Cents.</i>
From H. 89 to H. 110	337	71,564.1	19.44

Total levee work done, 71,564.1 cubic yards, at an average contract price of 19.44 cents per cubic yard.

The work was all completed by the United States to a grade about 2 feet below the standard established by the Commission.

The total cost of this work to the United States was \$16,286.73.

This includes office expenses, superintendence, surveys, engineering expenses, contingencies, and excludes \$1,427.81 earned by the contractors during the preceding season and paid to them this year. The average cost per cubic yard of levee work, including the above items, was 22.76 cents.

In addition to the above work by the United States the local levee board enlarged and repaired the levees on mile sections 1 to 29, inclusive, 62, 64, 65, 76 to 78, inclusive, 80 and 81, 12 H. to 19 H., inclusive, and 23 H., and built a small loop levee on mile section 19 H., doing in all 906,464 cubic yards of levee work at an average con-

tract price of 16.19 cents per cubic yard. The cost of this work was \$146,802.75, and the total expenses of the levee board for all purposes, including right of way, drainage, office expenses, surveys, and contingencies during the period covered by this report, were \$193,131.80.

During the period from May 1, 1901, to April 30, 1902, earth was added to the levee as follows:

	Cubic yards.
By the United States	71,564
By the local levee board	906,464
Total	978,028

None of the existing levee was lost or abandoned during the season on account of caving banks or from other causes.

The following is a summary of the earth in the levees of this district:

	Cubic yards.
Put up by United States and in place April 30, 1901	6,043,422
Added from May 1, 1901, to April 30, 1902	71,564
Total	6,114,986
Put up by levee board and others and in place April 30, 1901	13,147,081
Added from May 1, 1901, to April 30, 1902	906,464
Total	14,053,545
Levees in place April 30, 1902:	
Erected by United States	6,114,986
Erected by local authorities	14,053,545
Total	20,168,531

The levee of this district is generally in a very good condition, being completed to at least the standard cross section to a grade not more than 2 feet below the standard adopted by the Commission. At several places, however, the levee is threatened by caving banks and must be replaced in the near future. According to the latest data the estimated amount of earth required to raise and enlarge this levee line to the standard grade and cross section adopted by the Commission is approximately 7,600,000 cubic yards. The average cost of this work will probably be about 18 cents per cubic yard, or a total of \$1,350,000.

GENERAL REMARKS ON LEVEE WORK IN ALL LEVEE DISTRICTS.

Owing to the failure of the river and harbor bill and the consequent scarcity of funds, levee work has been confined to the completion of a few outstanding contracts and to the construction of one urgently needed loop around a threatened point in the levee. In consequence of the small amount of work done the cost of office and engineering expenses per cubic yard has been very high.

There is at present no unfinished work under contract, all contracts having been completed.

The total amount of levee work done during the year by the United States in the First and Second districts was 183,706.7 cubic yards, at an average contract price of 19.34 cents per cubic yard, and an average total cost of 24.41 cents per cubic yard, including superintendence, engineering, surveys, office expenses, etc. No expenses were incurred during the year on account of high water.

A map consisting of four sheets accompanies this report and shows the existing levees in these districts and the places where levee work has been done during the season, both by the United States and by the local levee authorities.

SURVEYS, GAUGES, AND OBSERVATIONS.

During the period covered by this report the following examinations and surveys have been made:

Survey of part of Plum Point Reach.

Minor examinations and surveys were made from time to time during the season in connection with work in progress or proposed.

PLANT.

Owing to scarcity of funds, operations under this head have been restricted to the ordinary care of the plant and the absolutely necessary repairs to that portion of it to be used in the restricted operations of the season. The cost of these repairs was \$702.09, and of the care of plant \$13,309.29. The plant pertaining to the district is now stored near Memphis, the floating property being moored to the left bank a short distance below the Memphis bridge. Much of the plant is now in poor condition and must be almost entirely rebuilt to make it serviceable for future work. (Further details will be found in the report of Assistant Engineer Nolty.)

Accompanying this report and forming part of it are the following papers and drawings:

Report of Assistant Engineer Nolty on operations at Plum Point Reach.

Report of Assistant Engineer Rees on operations at Hopefield Bend and in Wolf River.

Report of Assistant Engineer Nolty on care of and repairs to plant.

Money statement.

Abstract of proposals.

List of civilian engineers employed from May 1, 1901, to April 30, 1902.

Map of Plum Point Reach.

Map of Memphis and vicinity.

Map showing existing levees, First and Second districts (four sheets).

Respectfully submitted.

E. EVELETH WINSLOW,
Captain of Engineers.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

REPORT OF MR. AUG. J. NOLTY, ASSISTANT ENGINEER, ON CONSTRUCTION WORK IN FIRST DISTRICT DURING SEASON OF 1901-1902.

MEMPHIS, TENN., *April 30, 1902.*

CAPTAIN: I have the honor to submit my annual report of operations of the construction party operating at Plum Point Reach for the year ending with April 30, 1902.

Daniels Point.—An examination made here during the summer of 1891, while the river was at a fairly low stage, disclosed considerable damage to some of the crib dikes placed in 1899 and 1900. The upper 1900 dike was found to have slid down so that the crown at the shore end, which was originally at the 30-foot stage, was now at about the 5-foot contour. The smaller 1900 dike had slid down and out into the river, the lead showing 20 feet of water over it. The lower 1899 dike had been so much undermined along its downstream face that it was partly tilted over and had slid down the slope sidewise for a short distance. One of the salient points strengthened in 1899 had been cut away about one-half in width by eddy erosion.

The project for the season's work was simply to make such repairs as were possible with the available funds, in the hope that they would check further damage until funds sufficient to make more extended repairs became available. A careful examination upon the arrival of the construction party made it apparent that the small sum available for repairs here was entirely inadequate to permit of any repairs to either of the 1900 dikes. The repairs therefore were confined to restoring the 1899 dike, rebuilding the damaged salient, and constructing a small dike as an eddy breaker in the interval between them. The salient was restored by means of brush and stone filling, and its toe protected by a small connecting mat. Work was begun here October 9 and completed October 16, all brush here and at Fletchers Bend having been previously cut by hired labor. The brush cost \$1.18 per cord on barges.

The following is a summary of the work done:

Repairs to three crib dikes, aggregating 15,290 cubic feet.

One connecting mat, 37.5 squares.

Paving bank, 178 square yards.

The total field cost was \$1,653.73, distributed as follows:

Labor, including superintendence and subsistence	\$846.73
Brush, 184 cords	217.92
Stone, 185 cubic yards	277.50
Miscellaneous materials, etc.	27.36
Towing	284.22
Total	1,653.73

Fletchers Bend.—An examination made here during the summer showed that the work of 1888 had suffered some damage at its upper end, the damage apparently consisting of a separation between the subaqueous and upper bank revetment, caused by the settling of the former work. Careful investigation seemed to show that the river mats were still in good condition, and that therefore the damage could be repaired by placing a narrow connecting mat to restore proper connection between the bank and the river mats, and by regrading and repaving the narrow zone of damaged upper work, 815 linear feet of connecting mat being required. Of this, 255 feet were 40 feet wide and the balance 50 feet. The average width of the damaged paving, measured on the slope, was 7 feet. The repairs terminated just below a large washout, caused by the discharge of surface drainage through a ditch cut by farmers to drain their land; this was repaired by a brush and stone filling, so placed as to prevent any further enlargement of the hole, while not interfering with the free discharge through the drain.

Work was begun here October 16 and completed November 2, the latter date marking the termination of the season's work.

The following is a summary of the work done:

Three connecting mats, aggregating 382 squares.

Bank paving, 808 square yards.

Brush and stone filling in holes, 122 cubic yards.

The total field cost was \$4,146.48, distributed as follows:

Labor, including superintendence and subsistence	\$1,717.78
Brush, 510 cords	604.03
Stone, 657.29 cubic yards	985.94
Miscellaneous materials, etc.	54.74
Towing	783.99
Total	4,146.48

Cost of season's work:

Daniels Point	1,653.73
Fletchers Bend	4,146.48
Surveys	113.14

Total 5,913.35

Respectfully submitted.

AUG. J. NOLTY,
Assistant Engineer.

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. Army.

REPORT OF MR. W. M. REES, ASSISTANT ENGINEER, ON WORK IN THE SECOND DISTRICT DURING SEASON 1901-2.

MEMPHIS, TENN., April 30, 1902.

CAPTAIN: I have the honor to submit the following report of operations at Hopefield Bend and in Wolf River during the year ending April 30, 1902.

HOPEFIELD BEND.

The high water in the spring of 1901 was of very moderate proportions, and did but little injury to the works, and when the water had fallen it was found that the dike built at the lower end in 1900 for an "eddy breaker" had been quite successful, and had caused large deposits in its immediate vicinity, especially just along its downstream side, against which the eddy current impinged.

In the large pocket at station 42, which had been formed in 1898 and revetted during the same year, there was a very violent eddy, and when the water fell a crack was discovered in the paved slope just above the edge of the mattress and parallel thereto, while the mattress had settled some. This was the second time that this bank had cracked since the pocket was revetted, which was no doubt the result of the very violent eddy combined with the extreme steepness of the bank just under the low-water line. To prevent the recurrence of these faults it was decided to place across the middle of the pocket a crib dike of a length to extend from near the top of the dry bank to a short distance beyond the steep slope, and of sufficient height to destroy the violence of the eddy. It was believed that such a crib dike, together with the deposits it would accumulate, would act as a sustaining wall or buttress and prevent further faulting.

The head of the lower 1899 mat was turned over for a short distance, the result no doubt of its having been too lightly ballasted, and its having been sunk on some obstructions which held it off the bottom. This was repaired by weighting it with stone and placing a ridge of stone along the upstream side of the head.

One of the shore dikes terminates just at this mat head, and the lower portion of this dike being on soft ground had settled some, so it was raised to its original grade with a brush filling and stone paving.

The other repairs found necessary developed when the river fell to a very low stage and exposed the bank, on which there was an insufficient stone covering, and this was supplied.

The field work was begun October 8 and continued until December 10.

The crib dike built in the pocket at station 42 was of the usual brush and pole construction. It was 190 feet long, of which 120 feet was below the low-water line. The river portion was 22 feet wide at the base and 6 feet wide at the crown, and had a maximum height of 14½ feet. Its outer end was sunk in 38 feet of water. The dry or upper bank portion was 8½ feet high at the low-water line, and tapered to zero at 70 feet up the slope of the bank. It had a 4-foot crown, and side slopes of 1 on 1½, arranged in steps to hold the stone with which it was completely paved. The total volume of the dike was 747 cubic yards.

A new crib dike was built at the lower end of the work, about 200 feet below the 1900 dike and parallel to it, and was all above the low-water line, with its top joining the top of the bank. It was built and paved over the same as the dry end of the dike above described, was 116 feet long by 10 feet maximum height, and contained 513 cubic yards.

The other work consisted in placing 100 cubic yards of stone ballast on the turned-over mat head; building up the sunken crib dike abreast of this with 20 cords of brush and covering it with 50 cubic yards of stone; filling a drainage gully at the extreme end of the revetment with about 10 cords of brush and 10 cubic yards of stone, and distributing 300 cubic yards of stone over the bare places exposed by the very low water.

One barge of stone, containing 398.5 cubic yards, was purchased, and the balance, 460 cubic yards, was taken from the stock pile on the bank; 460 cords of brush were cut with hired labor from the Memphis bar, at a cost of \$442. 41.

The work done and cost was as follows:

Crib dikes constructed, 1,260 cubic yards.

Labor, including superintendence.....	\$1,712. 65
Brush, 430 cords.....	413. 55
Stone, 398.5 cubic yards.....	537. 75
Towing.....	94. 83
Ice.....	5. 00
Total	2,763. 78

The cost includes the paving of 312 square yards of surface of the dikes. Cost per cubic yard in place, \$2.19.

Repairing old work and building drain at gully:

Labor, including superintendence.....	\$835. 69
Loading 460 cubic yards of stone	149. 88
Brush, 30 cords.....	28. 86
Ice.....	2. 00
Total	1,016. 43

Summary.

Cost of dikes.....	\$2,763.78
Cost of other repairs.....	1,016.43
Total field cost	3,780.21
Memphis office expenses.....	1,619.56
Total expenditures, May 1, 1901, to April 30, 1902	5,399.77

The present condition of the Hopefield revetment is good, and no work is required other than may be necessary from time to time to maintain it in its present efficient condition.

DREDGING WOLF RIVER.

This work was resumed in the summer of 1901 as soon as the river had fallen to a sufficiently low stage for operating the dredge. The same plant was used as during the previous season, operated with a single crew only, the funds available not being sufficient to permit both day and night work.

The first dredging was done July 23 and the last December 16, when the winter rise began.

Although the river was considerably lower than in 1900, better navigable depths were maintained over a longer stretch of river, and with less volume of dredging, showing the improvement which the 1900 work made in the channel.

The stage of the river July 23 was 7.5 feet; it then fell to 3 feet on August 15, rose to 16.7 feet August 29, fell to 4.4 feet September 19, rose to 8.5 feet September 28, fell to 2 feet October 21, and continued below this stage until December 13, when it began to rise rapidly. For two weeks it was at the zero stage and under, the lowest being —0.3 foot on December 1. The high stage in the latter part of August was due to a rise in the Mississippi River.

On August 23 the river became too high for channel dredging, and the dredge was employed from that date to the 30th, inclusive, in cutting off a prominent salient just under the railroad incline. From August 31 to September 4, inclusive, operations were suspended on account of the high stage, but work was resumed the next day in the channel. On September 13 Wolf River began rising rapidly as the result of heavy local rains over its entire drainage basin. By the next morning the rise at the railroad bridge was 3 feet, and the current too strong for dredging. The rise continued until the 16th, when it began to fall slowly; dredging was attempted on the 17th, but was soon abandoned, as the current was still too strong for the steamer to handle the dump scows with safety. On the night of the 17th the flood from the head branches of the river appeared and the next morning added 3 feet to the stage at the railroad bridge, and during the entire day the river was filled with running timber and driftwood. It was not until the 23d that the current decreased sufficiently for a resumption of work.

This rise was the greatest that had occurred for a number of years. The Mississippi at the time was low and falling, making conditions favorable for the formation of a high slope in Wolf River and a resulting high velocity, and this for several days exceeded 8 feet per second.

The effect of the run-out on the channel was detrimental instead of beneficial, for while considerable of the finer material of the bed was scoured out, probably larger volumes of coarse sand and gravel were brought down from the upper part of the river and deposited in the dredged cuts, the navigable depths of which were decreased in quite a number of places.

A good navigable channel was maintained for 2½ miles from the mouth until October 21, after which date and for the balance of the season a good channel for boats drawing 4 feet was maintained to a short distance above the site of the old waterworks, or about 1½ miles from the mouth.

All the dredgings were loaded into dump scows and towed to deep water in the Mississippi and then dumped.

Summarizing the work done, there was removed the following:

	Cubic yards.
From the mouth to the railroad incline.....	35,035
From the railroad incline to Bayou Gayoso	4,705
From the shoal above the mouth of Loosa Hatchie to the old waterworks site.	3,080
From the old waterworks site to the Anderson-Tully mill	3,840
From the shoal just below the railroad bridge to a quarter mile above the bridge.....	4,400
Making a total of.....	51,060

104 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

In addition there were removed 80 saw logs, 4 snags, and 11 other obstructions. The dredge was engaged for a total of 985½ working hours, of which 89½ were lost in repairing machinery, etc., and 59 in moving for passing boats, etc., or the total time lost was 140½ hours, being about 14 per cent of the dredging time. The dredging rate was therefore 60 cubic yards per hour for actual dredging time, or 52 cubic yards per hour for total time, and this does not include the time consumed in removing logs, snags, etc., of which no record was kept.

The field cost was as follows:

For operating dredge:	
Labor	\$2, 273. 00
Fuel.....	621. 00
Machinery repairs.....	238. 12
Oils and engineer's supplies.....	51. 11
Ice.....	17. 40
	<hr/>
	\$3, 200. 63
For operating towboat.	
Labor	1, 447. 00
Fuel.....	214. 50
Machinery repairs, etc.....	23. 04
Oils and engineers' supplies.....	12. 00
Ice.....	10. 20
	<hr/>
	1, 706. 74
Total field cost.....	<hr/>
	4, 907. 37

Cost per cubic yard, 9.61 cents against 11.33 cents last year, when the dredge worked with double crew.

The total expenditures from May 1, 1901, to April 30, 1902, were as follows:

For operating dredge and towboat as above	\$4, 907. 37
For repairs made to floating plant.....	636. 12
For care of plant in ordinary	145. 00
For Memphis office expenses.....	657. 67
For surveys.....	94. 15
	<hr/>
Total	6, 440. 31

Cost per cubic yard on basis of total expenditures, 12.61 cents.

Respectfully submitted.

W. M. REES,
Assistant Engineer.

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. Army.

REPORT OF MR. AUG. J. NOLTY, ASSISTANT ENGINEER, ON CARE OF AND REPAIRS TO PLANT FOR YEAR ENDING APRIL 30, 1902.

MEMPHIS, TENN., April 30, 1902.

CAPTAIN: I have the honor to submit my annual report of the "Care of and repairs to plant" party for the year ending April 30, 1902.

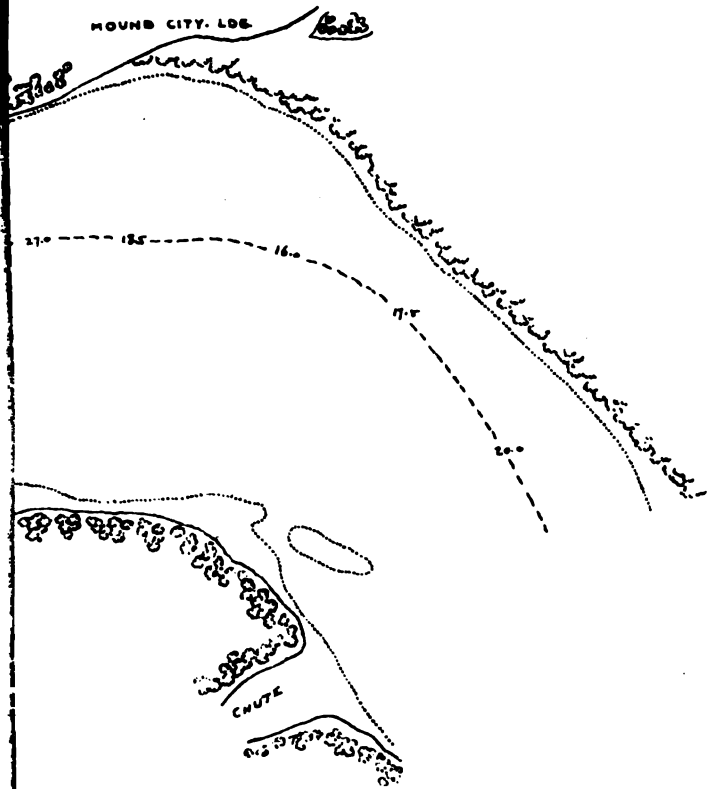
Owing to the failure of the river and harbor bill to become a law and the consequent shortage of funds, repairs were limited to such plant as was required for the season's work at Plum Point Reach, Hopefield Bend, and dredging of Wolf River, and the repairs made consisted simply in making the plant seaworthy for a short season's work.

The following is a list of plants operated upon and the cost of each piece:

Wolf River dredging outfit.—Dredge *Wolf*: Renewing compressed fiber lining on friction cones, calking hull and deck, overhauling machinery and rigging, and repairing roof; cost, \$226.67. Tug *Abbot*: Minor repairs were made to this boat at a cost of \$55.62. Dump scows: The sides, decks, and bins of these two scows were calked and pitched at a cost of \$166.62.

Construction plant, Plum Point Reach.—One mooring, one mat, and four brush barges were patched and calked for the season's work at a cost of \$116.81; one headquarters boat, one quarter boat, and the towboat *Graham* were placed in serviceable condition at an aggregate cost of \$53.12.





RIVER

NESSEE

tion of

NSLOW,

. S. A.

Asst. Engr.

ment.

3 0000

reduced
Gauge

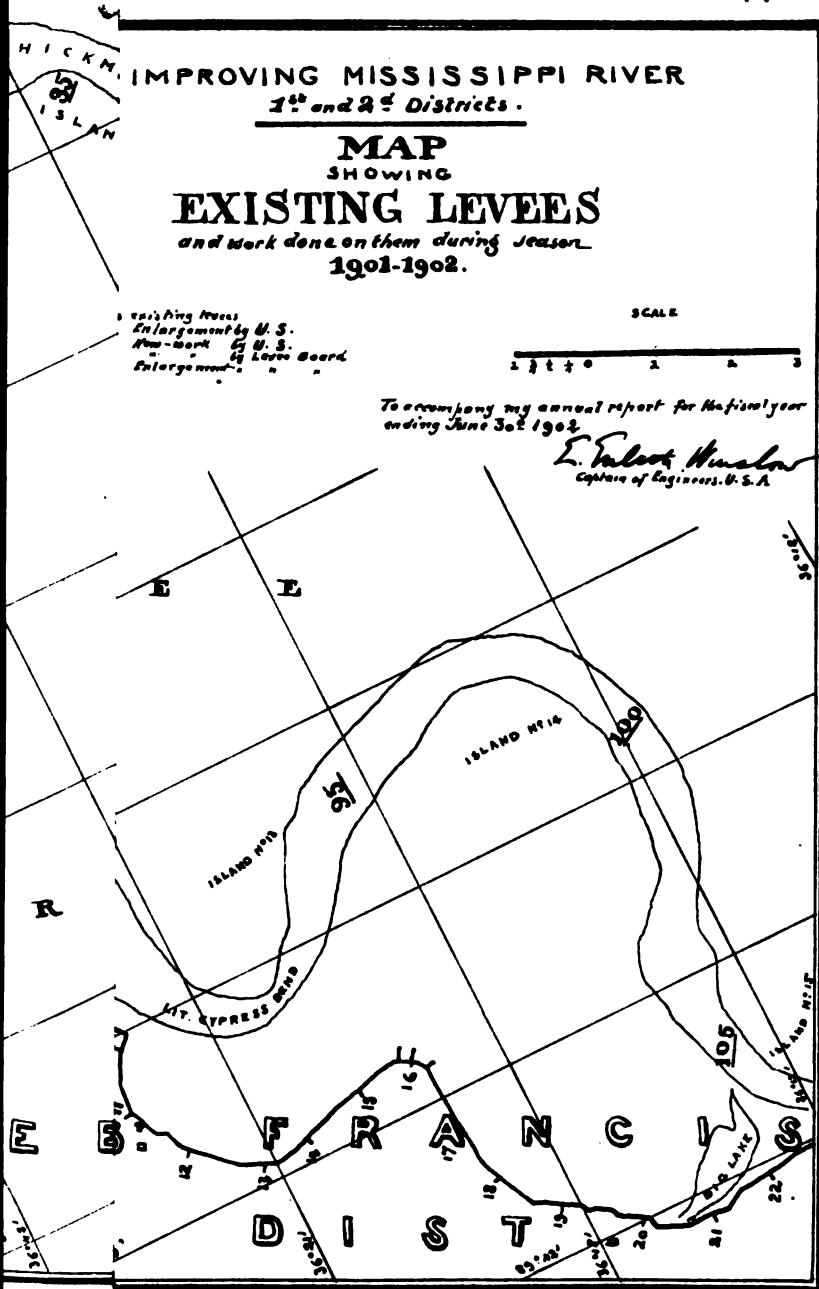
To accompany my annual report for
the fiscal year ending June 30, 1902

Page - 0.00

02

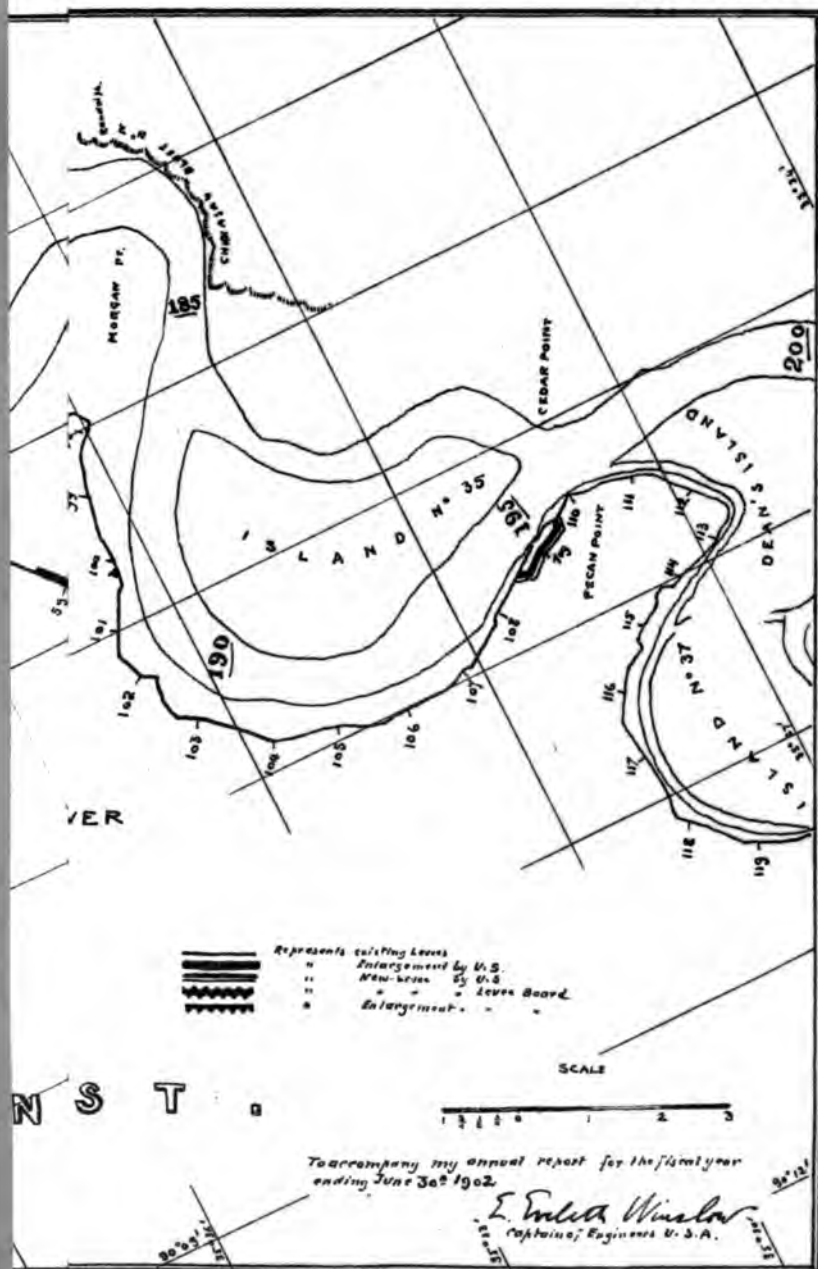
E. Enslin Wmslow
Captain of Engr's. U. S. A.

PLATE NO 1.



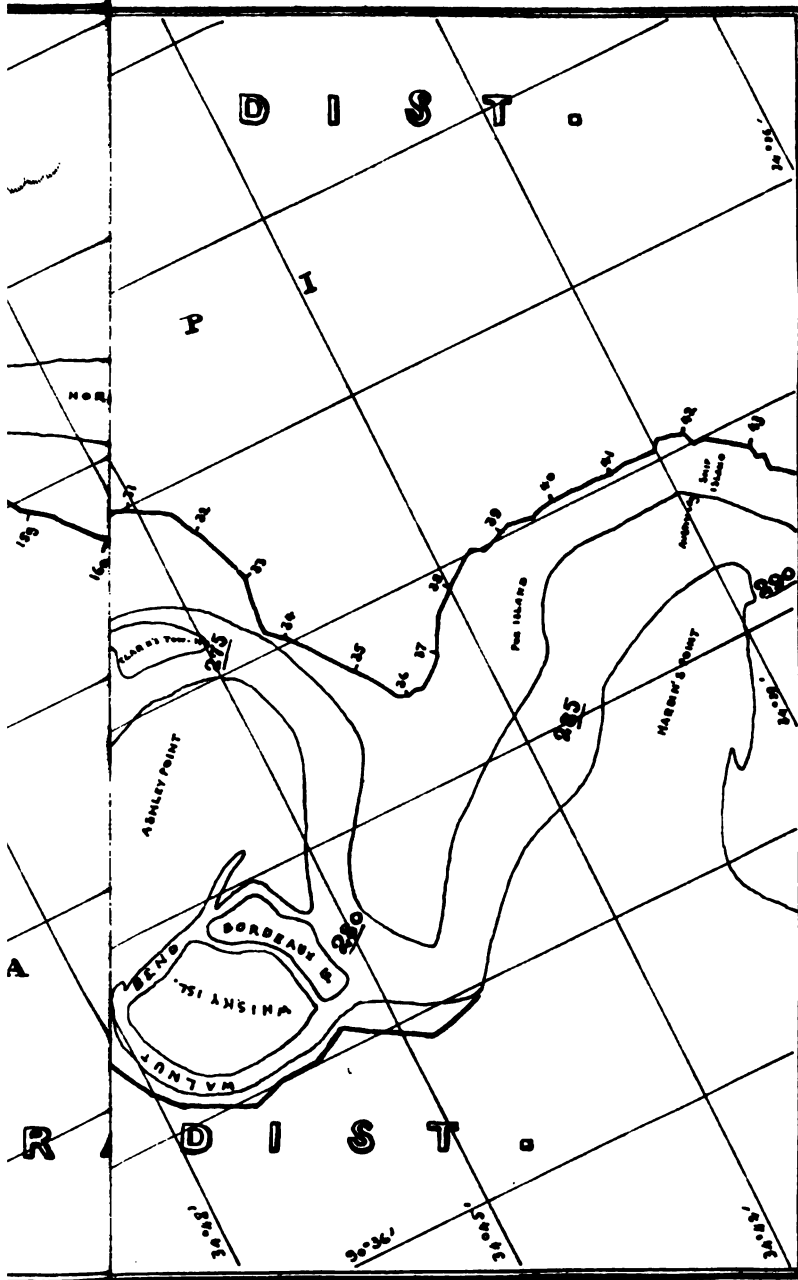
Eng 57 2

PLATE N° II



Eng 57 2

PLATE N° III.



4

5

6

7

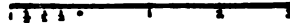
PLATE N° IV

IMPROVING MISSISSIPPI RIVER
1st and 2^d Districts.

MAP
SHOWING
EXISTING LEVEES
and work done on them during season
1901-1902.

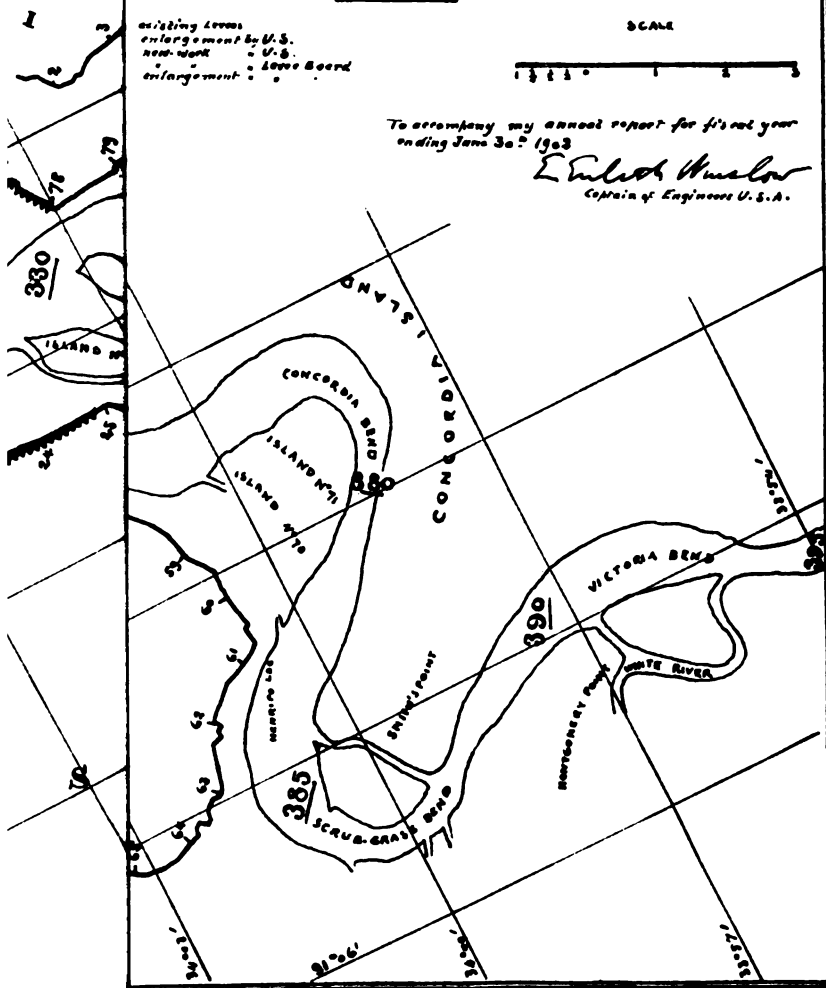
existing levees
enlargement by U.S.
new work - U.S.
" - " - Army Board
enlargement - " -

SCALE



To accompany my annual report for fiscal year
ending June 30th 1903

Emilio Huslow
Captain of Engineers U.S.A.



Construction plant, Hopefield Bend.—One mooring, one mat, and two brush barges were made ready for service on this work at a cost of \$83.25.

Repairs to plant for Wolf River work	\$448. 91
Repairs to plant for Plum Point Reach work	169. 93
Repairs to plant for Hopefield Bend work	83. 25
	<u>\$702. 09</u>
Care of plant	13, 309. 29
Total for care and repairs	<u>14, 011. 38</u>

Pile drivers Nos. 19 and 20 and grader No. 40 were inspected and condemned by proper authority during the year.

Respectfully submitted.

AUG. J. NOLTY,
Assistant Engineer.

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. Army.

FINANCIAL STATEMENT.

Appropriation for improving Mississippi River, First and Second districts.

HICKMAN, KY.

July 1, 1901. Balance unexpended	\$2, 413. 39
June 30, 1902. Amount expended during fiscal year	<u>1, 536. 61</u>
July 1, 1902. Balance unexpended	876. 78
July 1, 1902. Balance available	<u>876. 78</u>

NEW MADRID, MO.

July 1, 1901. Balance unexpended	3, 765. 40
June 30, 1902. Amount expended during fiscal year	<u>1, 974. 49</u>
July 1, 1902. Balance unexpended	1, 790. 91
July 1, 1902. Balance available	<u>1, 790. 91</u>
Amount that can be profitably expended in fiscal year ending June 30, 1904	<u>5, 000. 00</u>

CARUTHERSVILLE, MO.

July 1, 1901. Balance unexpended	401. 39
June 30, 1902. Amount expended during fiscal year	<u>399. 96</u>
July 1, 1902. Balance unexpended	1. 43
July 1, 1902. Outstanding liabilities	<u>1. 43</u>
Amount that can be profitably expended in fiscal year ending June 30, 1904	<u>50, 000. 00</u>

PLUM POINT REACH.

July 1, 1901. Balance unexpended	6, 644. 60
June 30, 1902. Amount expended during fiscal year	<u>5, 952. 61</u>
July 1, 1902. Balance unexpended	691. 99
July 1, 1902. Outstanding liabilities	<u>91. 99</u>
July 1, 1902. Balance available	<u>600. 00</u>
Amount that can be profitably expended in fiscal year ending June 30, 1904	<u>100, 000. 00</u>

106 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

HOPEFIELD BEND.

July 1, 1901. Balance unexpended.....	\$8,420.00
June 30, 1902. Amount expended during fiscal year.....	6,112.07
July 1, 1902. Balance unexpended.....	2,307.93
July 1, 1902. Balance available.....	2,307.93
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	25,000.00

MEMPHIS, TENN.

July 1, 1901. Balance unexpended.....	6,507.51
June 30, 1902. Amount expended during fiscal year.....	6,129.61
July 1, 1902. Balance unexpended.....	377.90
July 1, 1902. Balance available.....	377.90
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	10,000.00

HELENA, ARK.

July 1, 1901. Balance unexpended.....	2,374.52
June 30, 1902. Amount expended during fiscal year.....	1,984.04
July 1, 1902. Balance unexpended.....	390.48
July 1, 1902. Balance available.....	390.48
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	25,000.00

UPPER ST. FRANCIS LEVEE DISTRICT.

Amount that can be profitably expended in fiscal year ending June 30, 1904.....	75,000.00
---	-----------

LOWER ST. FRANCIS LEVEE DISTRICT.

July 1, 1901. Balance unexpended.....	32,201.51
June 30, 1902. Amount expended during fiscal year.....	22,128.21
July 1, 1902. Balance unexpended.....	10,073.30
July 1, 1902. Outstanding liabilities.....	273.30
July 1, 1902. Balance available.....	9,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	200,000.00

WHITE RIVER LEVEE DISTRICT.

July 1, 1901. Balance unexpended.....	14,736.92
June 30, 1902. Amount expended during fiscal year.....	10,523.40
July 1, 1902. Balance unexpended.....	4,213.52
July 1, 1902. Outstanding liabilities.....	213.52
July 1, 1902. Balance available.....	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	100,000.00

MISSISSIPPI RIVER COMMISSION.

107

UPPER YAZOO LEVEE DISTRICT.

July 1, 1901. Balance unexpended	\$26,645.22
June 30, 1902. Amount expended during fiscal year	19,098.10
July 1, 1902. Balance unexpended	7,547.12
July 1, 1902. Outstanding liabilities.....	547.12
July 1, 1902. Balance available	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	70,000.00

REELFOOT LEVEE DISTRICT.

Amount that can be profitably expended in fiscal year ending June 30, 1904.....	50,000.00
---	-----------

SURVEYS, GAUGES, AND OBSERVATIONS.

July 1, 1901. Balance unexpended	331.95
June 30, 1902. Amount expended during fiscal year	212.90
July 1, 1902. Balance unexpended	119.05
July 1, 1902. Outstanding liabilities.....	119.05
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	5,000.00

PLANT, FIRST AND SECOND DISTRICTS.

July 1, 1901. Balance unexpended	17,758.60
June 30, 1902. Amount expended during fiscal year	13,760.18
July 1, 1902. Balance unexpended	3,998.42
July 1, 1902. Outstanding liabilities.....	498.42
July 1, 1902. Balance available	3,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904.....	100,000.00

APPROPRIATION FOR IMPROVING HARBOR AT MEMPHIS, TENN. (WOLF RIVER).

July 1, 1901. Balance unexpended	138.37
June 30, 1902. Amount expended during fiscal year	138.37

APPROPRIATION FOR LEVEE IN VICINITY OF WALNUT BEND, ARK.

Amount appropriated by river and harbor act approved June 13, 1902...	90,000.00
July 1, 1902. Balance unexpended	90,000.00
July 1, 1902. Balance available	90,000.00

MISCELLANEOUS.

July 18, 1901. Amount received from proceeds of Government property.	255.00
Feb. 5, 1902. Amount received from B. F. Dame for rent of island in the Mississippi River, near Australia, Miss., for year 1902.....	1.00
	256.00
July 18, 1901. Amount deposited to credit of Treasurer of the United States, account proceeds Government property	255.00
Feb. 5, 1902. Amount deposited to credit of the Treasurer of the United States on account rent of island in Mississippi River, near Australia, Miss., for year 1902.....	1.00
	256.00

APPENDIX 3.

REPORT OF CAPT. CHARLES L. POTTER, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 20, 1902.

COLONEL: I have the honor to submit the following report of operations in the Third district, improving Mississippi River, from May 1, 1901, to May 1, 1902:

The Third district extends from the Coahoma-Bolivar County line on the left bank (365 L.), and the mouth of White River on the right bank (393 R.), to the latitude of Warrenton, Miss. (607 L.). In its improvement works of bank protection have been executed at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, Lake Providence, and Delta Point; the systematic improvement of Lake Providence Reach was attempted, and levees have been constructed and enlarged in the Upper Tensas and Lower Yazoo levee districts. All of these localities are shown on the accompanying map of the Third district.

The operations of the past year have included repairs to the revetment at Lake Providence, the construction and maintenance of levees, towing stone, brush, and poles for the season's work, the repair and care of plant, and surveys of Lake Providence Reach and Choctaw Bend.

LAKE BOLIVAR FRONT (417 miles below Cairo).

The revetment at this place was built to hold a bank whose caving endangered a large levee across the head of Lake Bolivar. About 4,250 linear feet of revetment were constructed in 1888-89, and repairs were made in 1889, 1892, and 1893. Details of the work are given in the Annual Reports of 1889, page 2704; 1890, page 3252; 1893, page 3752, and 1894, page 2919, and maps accompany the reports of 1889 and 1890.

No work has been done since 1894. The revetment at this place is protected to some extent by a narrow bar formed a short distance from the work, and the tendency of the river appears to be toward taking this outside channel at all stages, the caving of Island 76 above and a hard point at the lower end of the island throwing the current away from the revetment. There are a few places where the upper bank paving has been disturbed, probably occasioned by the use of this point as a landing for steamers, but this damage can easily be repaired by a few bargeloads of stone. With these exceptions the revetment is in good condition for a length of 3,775 feet. The total expenditures under this allotment have been \$145,358.04.

ASHBROOK NECK (446 miles below Cairo).

The revetment at this place was built to prevent a threatened cut-off, the minimum distance across the neck having been reduced to about 2,000 feet. About 2,820 linear feet of revetment were constructed in 1890-91, 4,300 feet in 1891-92, 2,610 feet in 1892-93, 1,475 feet in 1894-95, and repairs, principally to upper bank paving, were made in 1893-94 and 1897-98. Repairs were also made in 1899-1900. In the season 1900-1901, 4,000 feet of standard mat, 250 feet wide, were laid to reinforce the upper half of the work, and one large break repaired. A levee 7,300 feet long was built along the axis of the neck in 1891-92 to prevent flow across the neck, but it was destroyed in the next flood. Details of the work are given in the Annual Reports of 1891, page 3639; 1892, page 3170; 1893, page 3752; 1894, page 2920; 1895, page 3805; 1898, page 3370; 1899, page 3537; 1900, page 4825, and 1901 (Sup.), page 267. Maps accompany the reports of 1892, 1893, 1900, and 1901.

No work has been done during the past year.

The revetment covers a distance of nearly 10,000 feet, and is in good condition, but may need some repairs in the future, and should be reinforced with a fascine mat over the remainder of the work.

The total expenditures under the whole allotment have been \$567,458.25.

GREENVILLE HARBOR (478 miles below Cairo).

The revetment at this place was built to protect the town of Greenville, which was rapidly caving into the river when the work was begun in 1887. The first project was to hold the bank with submerged spur dikes, consisting of cribs resting on foundation mats. In 1887, 1888, and 1889 12 crib dikes were built and 1 longitudinal pile dike, and mats were placed between some of the spur dikes. Caving continued,

however, in the bend above, and during the flood of 1891 the upper dikes were flanked, 4 spur dikes and the longitudinal dike being carried away. The revetment of the bank above the remaining dikes was then begun, 6,600 linear feet being built in 1891-92, 4,450 feet in 1892-93, and 3,087 feet in 1894-95, woven mats being used in all this work. Repairs were made to upper bank paving in 1893 and 1894. In the flood of 1894 the upper remaining spur dike was carried away, leaving 7 spur dikes still in position. Breaks in the revetment were repaired by the construction of about 677 linear feet of new revetment in 1896, using fascine mats, and 1,850 feet in 1897-98, together with considerable new upper-bank work. In 1899 extensive repairs were made by sinking 5,108 linear feet (14,666 squares) of channel mat and 10 pocket mats, amounting to about 2,843 squares, and paving 5,882 squares of bank. Three small dikes were also built to prevent wash on top of the bank, which threatened to flank the line. Some small repairs were made in 1899-1900. In the season 1900-1901 two breaks were repaired, and about 1,100 feet of channel mat were built to reinforce the old type of mat.

The details of the above operations are given in the Annual Reports of 1888, page 2280; 1889, page 2706; 1890, page 3240; 1892, page 3173; 1893, page 3753; 1894, page 2920; 1895, page 3805; 1897, page 3726; 1898, page 3370; 1899, page 3538; 1900, page 4825, and 1901 (Sup.), page 267. Maps accompany the reports of 1888, 1889, 1890, 1892, 1893, 1899, 1900, and 1901.

A cave has recently occurred in the revetment and is now about 300 feet long (ranges 104-107), but appears to be confined to the upper bank paving and does not appear serious, but, owing to the fact that it is at the upper end of the work, may call for some extension of the work during the coming season. There are also left about 600 feet of the old type of mat which should be reinforced with new standard mat. This was in the project for 1900-1901, but owing to lack of funds had to be left undone.

No work has been done during the past year.

The length of revetment work at this place is about 11,600 feet, and about 2,900 feet is protected by the dikes below; all of which revetment appears to be in good condition except at the point above mentioned. The total expenditures have been \$878,058.77, not including \$42,277.10 contributed by the town of Greenville in 1887.

LAKE PROVIDENCE REACH (517 to 552 miles below Cairo).

Earlier works.—This was one of the reaches first selected by the Mississippi River Commission for systematic treatment. The least low-water depths on its crossings, before its improvement was undertaken, are variously reported as $4\frac{1}{2}$ and 5 feet. The original project provided for giving the low-water channel an approximately uniform width of 3,000 feet, by constructing contraction works, closing all the chutes, and holding the caving banks. Instead of covering the entire reach of 35 miles, however, as originally intended, the works as built were confined to a reach of about 20 miles, from 522 to 542 miles below Cairo. Operations were begun in 1882 and actively prosecuted until 1885, and some repairs were made to these earlier works in 1886 and 1888-89. The Duncansby, Mayersville, Baleshed, and Stack Island systems of dikes were constructed on the Mississippi side of the channel and the Cottonwood and Elton systems on the Louisiana side, and bank revetment was constructed at Louisiana Bend and Mayersville Island. The total lengths of the various constructions were about as follows: 112,396 feet of pile dikes, 48,238 feet of foot mats between dikes, 16,547 feet of foot mats along the dikes, 5,588 feet of screens in front of the dikes, 13,561 feet of wattling between dikes, 520 feet of shore revetment at the ends of dikes, and 33,476 feet of bank revetment. See Annual Report of 1895, page 3843, for a tabular summary of the work. The details of these works are given in the Annual Reports of 1883, page 2285; 1884, page 2814, and 1885, pages 2748 and 2960. Maps accompany the reports of 1883, 1884, 1888, and 1889.

These earlier works had a beneficial effect on the channel, but they were comparatively weak, and were lost, partly through lack of funds for their maintenance and Congressional limitation of the use of bank revetment. The Duncansby system was reported as practically destroyed by 1886, the Louisiana Bend revetment by 1887, and by 1889 only portions of the system at Baleshed Bar and Stack Island remained out of all the works that had been built. Parts of these are still in existence where not exposed to the destructive action of the river.

Louisiana Bend revetment (522 R.).—In 1889 active work was resumed. It was decided torevet the caving bank near the head of the reach in Louisiana Bend, hoping thus to give greater permanence to the channel throughout the reach. About 6,024 linear feet of revetment were built in 1889-90, 5,224 feet in 1891-92, and 5,835 feet in 1892-93, when further operations were suspended. The type of revetment

used was much stronger than that formerly employed, consisting of woven mats below water, 260 to 345 feet wide, and upper bank paving of stone 10 inches thick. On account of the unstable nature of the bank along the mouth of Old River it was necessary to make some repairs each year to the upper bank paving where sloughs occurred during low-water stages, and in 1892 and 1893 seven short spur dikes of brush and stone were built on the upper bank where the high waters caused scouring behind the revetment. Breaks in the revetment were repaired in 1896-97 by the construction of about 1,247 linear feet of new revetment, using fascine mats. The details of these operations are given in the Annual Reports of 1890, page 3229; 1892, page 3177; 1893, page 3754; 1894, page 2921; 1895, page 3806; 1896, page 3653; and 1897, page 3727. Maps accompany the reports of 1890, 1892, 1893, and 1896.

After the flood of 1897 a number of breaks appeared between ranges 127 and 156. Thorough repairs would have required the practical renewal of this portion of the revetment. In view of the small amount of available funds and the difficulty that had been experienced in holding this part of the bank, it was decided to abandon this part of the work for the present.

No work of construction has been done here during the year and none is recommended. The length of revetment, including the above breaks, is about 15,820 feet, measured along the shore edge of mats.

Lake Providence revetment (540 R.).—This revetment (see accompanying map of revetment at Lake Providence) was built to hold a rapidly caving bank that threatened to destroy the town of Lake Providence and the important levee across the foot of the lake. About 4,780 linear feet of revetment were built in 1894-95, 5,360 feet in 1895-96, and repairs to upper bank paving were made in 1898. In January, 1899, work was begun to extend the revetment a short distance up river, but after sinking two small mats the river rose and work was suspended. In 1899-1900 the revetment was extended up river 1,200 feet and two breaks repaired. In 1900-1901 the revetment was extended up river 1,800 feet and existing breaks and several that occurred during the progress of the work were repaired. The details of the work are given in the Annual Reports of 1895, page 3806; 1896, page 3653; 1898, page 3372; 1899, page 3540; 1900, page 4826; and 1901 (Sup.), page 268. Maps of the work accompany the reports of 1896, 1900, and 1901.

The approved project for 1901-1902 contemplated the repair of several breaks in the revetment, at an estimated cost of \$50,000, which was transferred from the levee districts and allotted from funds in the hands of the president of the Commission. The repairs were completed according to project. For details of the season's work see reports of Mr. Arthur Hider and Mr. George C. Thomas, appended.

The length of this revetment work is now about 12,800 feet, and is all apparently in good shape.

Dredging.—The project for the past season also contemplated dredging across the point of Stack Island Bar, to assist an apparent tendency of the river to go in that direction and thus relieve the great strain on the revetment near the upper end, and especially at the salient point at range 110. (See accompanying map, showing dredged channel and surveys over dredged area.) The dredge *Ganima* began work on the cut October 22, 1901, and continued work to December 2, 1901, working forty days. The channel silted up some, but kept open as well as was expected, two surveys made in January and February, after two decided rises and falls in the river, showing great improvement in the conditions at this point. The point of impact against the revetment has been thrown considerably farther down, and, while the channel has narrowed at range 164, the conditions are apparently much better than they were a year ago. It is believed that a survey after the river falls again will show more marked improvement.

This work was done by the secretary of the Commission and paid for from funds in his hands, and no data is at hands giving the cost of the work.

The total expenditures for the year, exclusive of dredging, have been \$41,097.47, and for the whole reach from the beginning of the work, \$3,769,132.61. The total expenditures for Lake Providence revetment alone have been about \$383,988.95.

DELTA POINT (598 miles below Cairo).

The cut-off that occurred at Vicksburg in 1876, and the subsequent shoaling of the channel leading from the river to the resulting lake front of the city, practically destroyed the harbor of Vicksburg for low-water commerce.

The first operations undertaken for the improvement of the harbor consisted in revetting the rapidly caving bank at Delta Point, as its continued recession was increasing the distance from the harbor proper to the channel of the river. From

1878 to 1881, before the Mississippi River Commission assumed charge of the work, there were built about 5,400 linear feet of revetment, one mattress spur dike, and two screen dikes, at a total cost of \$203,229.87. The details of the work for this earlier period are found in the Annual Reports of 1878, page 637; 1879, page 974; 1880, page 1333; 1881, page 1384, and 1882, page 1502.

The river and harbor act of August 2, 1882, placed this work under the supervision of the Mississippi River Commission. The work of revetment at Delta Point was continued, 1,100 linear feet of revetment being built in the season of 1882-83, 2,200 feet in 1883-84, 2,083 feet in 1884-85, 1,065 feet in 1893-94, and repairs to upper bank paving were made in 1898. On account of unfavorable season for work, the project for 1898 was not carried out, but left to go over to 1899. Practically all the work prior to 1882 is destroyed or covered by the later work. Only the mats of 1893-94 had the present standard width of 300 feet, the earlier ones being from 150 to 175 feet wide. Extensive repairs were made in 1899-1900. Details of the work under the Commission are given in the Annual Reports of 1883, page 2290; 1884, page 2820; 1885, pages 2787 and 2964; 1889, page 2709; 1893, page 3754; 1894, page 2921; 1898, page 3373, and 1900, page 4827. Maps accompany the reports of 1883, 1884, 1888, 1889, 1893, and 1900.

No work has been done during the past year.

During the past season some caving has occurred above the work, but the upper end of the revetment is protected by a hard point and there is no immediate danger of the work being flanked. As the levee is some distance from the bank, no serious trouble can result from the caving.

The improvement of Vicksburg Harbor proper is now in charge of the Engineer Department, in accordance with the project adopted by the river and harbor act of July 13, 1892, providing for the diversion of the Yazoo River into Centennial Lake. A summary of the work done in the harbor by the Mississippi River Commission is given in the Annual Report of 1897, page 3728.

The total amount expended under the Mississippi River Commission has been \$442,724.75 in Vicksburg Harbor and \$186,256.21 at Delta Point, making the total expenditures at the latter point \$389,486.08.

LOWER YAZOO LEVEE DISTRICT (365 to 592 miles L. below Cairo).

This district extends in Mississippi from the Coahoma-Bolivar county line to the mouth of the Yazoo River, being practically coterminous with the local Mississippi levee district.

The levee line is continuous from the upper end of the district to Kigers on Eagle Lake. Its length is about 188.3 miles, covering about 220 miles of the river.

During the past year no work of construction has been done by the United States, and the local board has built about 1,796,900 cubic yards. A large portion of the revenues of the local levee board is expended for rights of way and damages to property affected by levee work. The net contents of the line May 1, 1902, are about 32,150,229 cubic yards. The United States have built altogether about 16,436,367 cubic yards. No figures are available showing what portion of the existing line has been built by the United States. Tabular statements of expenditures and work done by the United States accompany this report.

The work done by the United States during the year has consisted of maintenance (sodding and weed cutting) and a complete survey of the line with frequent cross sections, and establishment of high-water gauges and bench marks. This survey has shown that the levees do not keep up to grade, probably due partially to shrinkage and partially to settlement. For discussion of this feature see report of Mr. A. Miller Todd.

This survey having shown the levees generally lower than was supposed, the amount necessary to bring the whole line to the provisional grade, 3 feet above high water of 1897, is larger than that of last year, being 1,235,000 exclusive of new loops. New loops will be needed during the next few years amounting to 3,087,000 yards. The total yardage necessary to bring the whole district to the ultimate grade is 18,079,515.

No high-water work has been necessary during the year, as the river has scarcely been out of its natural banks.

For additional details of work in this district see report of Mr. A. Miller Todd, appended.

The expenditures for maintenance of levees during the past year in the Lower Yazoo district made by the United States have been \$18,833.28, and the total expenditures in this district \$2,914,746.29.

UPPER TENNAS LEEVE DISTRICT (402 to 606 miles R. below Cairo).

This district extends from the Arkansas River to a point in Louisiana opposite Warrenton, Miss. There is a continuous levee line about 171.65 miles long, extending from Costello's gin on Amos Bayou, along that bayou and Cypress Creek to the Mississippi River, and thence along the river to the lower end of the district.

The district is protected from overflow of the Arkansas River by a levee line along that river from the vicinity of Pine Bluff to a point below Lake Jefferson. From Pine Bluff to Red Fork (57.3 miles) this line is of comparatively weak section, built and hitherto maintained by the local authorities. From Red Fork to the foot of Lake Jefferson and thence toward the junction of Cypress Creek and Boggy Bayou (14.85 miles in all) the levee has been built principally by the United States. During the past year the contract for the extension of this levee has been completed, giving a total length of levee under the jurisdiction of the United States of 186.7 miles in this district.

During the past year there have been added to the line by the United States about 199,684 cubic yards and by the local authorities about 741,651 cubic yards. The yardage thrown out by the construction of new loops in Louisiana was about 537,113 cubic yards, thus giving total contents of levees May 1, 1902, about 28,579,718 cubic yards. The United States have put in altogether in this district about 21,686,858 cubic yards. No figures are available showing what portion of the present line has been built by the United States. Tabular statements of expenditures and work done by the United States accompany this report.

It is estimated that it will require about 4,276,599 cubic yards to bring the levees in this district to the provisional grade of 3 feet above the high water of 1897 with standard section and close the gap between the Arkansas River system and the Mississippi River system, without any changes in the present lines, and 21,216,857 cubic yards for the ultimate grade adopted by the Commission, which averages about 5.5 feet above the high water of 1897, including two new loops, amounting to 1,701,732 cubic yards, which will be necessary before this increase in grade can be made. For the 3-foot grade that portion of the above yardage necessary to close the gap between the two systems is 1,340,716 and for the ultimate grade 1,942,115 cubic yards.

About 467,873 cubic yards of work have been let in this district during the year, all of which was new work, at average price of 19.38 cents per cubic yard, the greater portion being paid for by the local levee boards.

The two contracts reported as incomplete in the last annual report have been finished. The only new work undertaken during the year was a loop at Lucca Landing, for which contract was made by the United States with the understanding that the expenditures should be limited to \$25,000 and that the remainder should be paid by the local levee boards. The contracts have been completed, and the front levee has caved into the river. The total expenditure by the United States under these contracts was \$22,980.77.

There were no high-water operations in this district during the year.

For additional details of work in this district see report of Mr. E. C. Tollinger, appended.

The expenditures by the United States during the past year for levees in this district have been \$59,315.21, and the total expenditures by the United States have been \$4,274,598.42.

SURVEYS, GAUGES, AND OBSERVATIONS.

None of the regular surveys of bank revetments were made during the year except that at Lake Providence, which was made in August, and at the same time a survey was made of the river from Homochitto to the town of Lake Providence. Four surveys were made over the dredged area at Lake Providence in October, December, January, and February, and a survey of Choctaw Bend made in December.

The expenditures during the year have been \$2,233.94, and under this allotment have been to date \$82,919.50.

STONE.

Stone for the work during the season was obtained from the supply on hand, which was quarried at the Government quarry on Little Red River and towed to Greenville during the spring of 1901.

This stone cost, as shown in the last annual report, somewhat more than that obtained by contract, but it is believed that, under favorable conditions for quarrying and towing, it could be brought down below the contract price, and the stone

thus obtained is vastly superior to that furnished by contract, resulting in much less labor to place and a very superior pavement, the blocks being of regular size and shape. Besides, there is a very great advantage in having the supply of stone on hand when the season's work begins, thus avoiding expensive delays due to the failure of contractors to begin delivery promptly or to deliver at a proper rate.

No operations have been carried on during the year except the care of the property and plant, last year's towing having been very nearly completed at the date of the annual report.

The expenditures during the year have been \$11,645.21, and under the allotment \$234,204.80.

GENERAL REPAIRS TO EXISTING WORKS.

The balance of this allotment has been expended and all charged to the works on which used.

PLANT.

Repairs to plant were made during the year as shown in the detailed statement accompanying the report of Mr. Hider. The cost of repairs amounted to \$6,113.51, and the cost of caring for the floating plant and other property amounted to \$22,072.72. Of this, \$2,607.16 was taken from other allotments.

The total expenditures under this allotment have been \$799,215.39.

The steamer *Emma Etheridge* was sunk December 13 by striking a snag, which tore a long hole in her bottom. An attempt was made to raise her, but owing to a rapidly rising river and her old condition she was condemned and sold.

The following papers and maps accompany this report:

Report of Mr. Arthur Hider on surveys, revertment work, stone, and plant, with report of Mr. Geo. C. Thomas appended.

Report of Mr. A. Miller Todd on levees in Lower Yazoo district.

Report of Mr. E. C. Tollinger on levees in Upper Tensas district.

Table showing cost of work done by the United States on levees.

Map of Third district.

Map of revetment at Lake Providence and map showing the surveys of dredged area at Lake Providence.

The list of civilian engineers, abstracts of proposals, and financial statements will be forwarded on or about July 1.

Very respectfully, your obedient servant,

CHAS. L. POTTER,
Captain, Corps of Engineers.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Mississippi River Commission

REPORT OF MR. ARTHUR HIDER, ASSISTANT ENGINEER.

GREENVILLE, Miss., May 7, 1902.

SIR: I have the honor to submit the following report of surveys, construction work, repairs to plant and care of same, from May 1, 1901, to May 1, 1902.

SURVEYS.

The usual annual revetment surveys were omitted on account of lack of funds.

In August a complete survey was made over the Lake Providence revetment, and also a special survey of the river extending from Homochitto (536 L.) to Lake Providence (542 R.).

The party began work on August 9 and finished August 22. The field party was delayed in returning to Greenville, by the sinking of the quarterboat, until the 27th, when the party was disbanded. The plotting and reducing of notes was finished on September 10.

The field work consisted of a complete survey over the revetment work (70 ranges) and the sounding of 21 ranges across the river from Homochitto to Lake Providence for comparison of future changes.

In October a special survey was made over that part of the river in the vicinity of Stack Island Bar (539-540 L.) where dredging was to be done. The survey extended from a point about 3,000 feet above to a point 2,000 feet below the proposed cut

through the bar. The field party left Greenville October 22, completed the field work on the 26th, and returned to Greenville on the 27th and was disbanded. The plotting and reducing notes was finished November 7. The field work consisted of the location and sounding of 10 ranges across the river. Office work consisted of plotting the sections and preparing maps.

On November 21 a party was organized to make a special survey of Choctaw Reach (433-438 L.). The party was transferred to Lake Providence on November 25 to make a survey over the dredged channel, arriving there November 27. This latter survey was finished on December 6, and the party returned to Choctaw Bend to finish the survey begun at that point, which consisted of the sounding of 15 ranges and locating changes in shore lines for comparison with survey of last year. The plotting of both these surveys was completed on January 31.

A party was organized January 4 to make a survey over the dredged channel at Lake Providence, and completed the survey and returned to Greenville on the 7th.

Another party was organized on February 27 to make a similar survey, and returned to Greenville on the 29th. The outfit, consisting of the steamer *Vedette*, was transferred to levees. The boat and outfit were returned to the fleet on March 19.

The amount expended for surveys was \$3,695.65.

These surveys were under the direct charge of Mr. L. Y. Kerr, junior engineer.

CONDITION OF REVETMENTS.

As no special surveys were made over the revetments during the season, except at Lake Providence, their condition can be reported only from a general examination of their apparent state.

An inspection recently made shows that but little damage has been done by the recent rises.

Lake Bolivar revetment (417 L.).—This revetment is in fair condition. No material change has occurred in the conditions existing last year.

Ashbrook Neck revetment (446 L.).—The revetment here has stood very satisfactorily. No defects of any importance have developed during the year. There is active caving above the head of the revetment.

Greenville Harbor revetment (478 L.).—With the exception of a cave that recently occurred near the upper end, in the upper bank slope, the revetment is in apparently good condition.

The cave or slip referred to took place May 2, 1902, and is about 300 feet long (ranges 104-107). Soundings show that the damage is confined to the upper bank work and that the mattress work in front has not been injured.

The conditions at the head of the revetment are somewhat similar to those at Lake Providence.

It will be necessary to repair this work during the coming season or much more serious damage will ensue, as this is practically the head of the present revetment.

Louisiana Bend revetment (522 R.).—No material change in conditions from those of last year has been noticed.

Lake Providence revetment (517 R.).—This revetment is in good condition. There are slight settlements in the upper bank slope at ranges 112-114 and 115, but the stone is still intact on the slope. No caving has occurred above the head of the work.

Delta Point revetment (598 R.).—This revetment is in very satisfactory condition, no changes having been noticed. There has been considerable caving above the work.

REPAIRS OF REVETMENTS.

Lake Providence revetment (540 R.).—An examination made of the Lake Providence revetment early in May, 1901, showed that during the high water the upper bank slope had been injured at several places. A careful survey over the revetment was made early in August to determine the extent of the damage done. The conditions then found were as follows:

The old work was intact from the lower end (range 14) to range 87, a distance of about 2,300 feet. No material change seemed to have occurred from the conditions existing last year, when the previous survey was made, except from range 72 to range 84, where the heavy deposits of former years had been scoured off the upper bank slope above the zero line. From range 84 to range 87 there had been a deep scour through the outer one-third of the mats, and also beyond the outer edge of the mats themselves.

From range 87 to 97, a distance of 1,000 feet, the scour through the mats had been excessive and the upper bank slope had been practically destroyed.

From range 104 to 105, a distance of 100 feet, the upper bank slope had also been

destroyed. From range 111 to 114 the bank slope had settled, and from range 118 to 127 the upper bank slope, with the paving, had caved into the river.

From range 123 to the upper end of the revetment at range 139+60 the work was in good condition.

The estimated cost of the work necessary to renew 1,700 linear feet of the upper bank slope and to construct 5,000 squares of standard mattress work, not including the value of material on hand, was \$47,586.65. The actual amount paid for labor and material purchased and used in the work was \$36,604.18.

The total cost of the repairs actually made, allowing for the value of stone, wire strand, wire, etc., used from the stock on hand, was \$62,722, and the amount of repair work done was 1,650 linear feet of upper bank slope renewal and the construction of 5,796 squares of mattress work.

Repair work of this class is always much more expensive than new work, on account of the short mats and the additional cost of moving from place to place, requiring changes in the position of headlines, etc. The building of the heads of the mats, with the necessary line work, is the most expensive part of mat building.

The repairs were made under Mr. George C. Thomas as superintendent of construction, whose report, submitted herewith, gives in detail the amount and cost of the work.

The conditions at the beginning of the season were very similar to those of previous years. There had been a continued building and extending out of the sand bar on the opposite side of the river, narrowing the channel width, with a corresponding deepening along the revetment. The configuration of the river above being such that the main current impinged almost directly against the bank, this had caused a deep pocket and an abrupt change in the direction of the current at the head of the revetment, causing a strong eddy action below, which had already given much trouble. The strong upstream current had damaged the slope in many places and scoured through the outer edge of the mats.

To relieve the situation and to direct the current along the upper side of the bar on the opposite side of the river, the construction of a series of dikes between ranges 9 and 13 along the lower end of the middle bar, so as to direct the current along the face of the bar on the opposite side, was suggested, this work to be assisted by dredging a channel through and around the point of the bar.

It was believed that this plan would relieve to a great extent the severe stress to which the upper part of the revetment had been subjected for several seasons past, extensive repairs having been required annually to hold the work intact at this point.

The construction of the dikes was not authorized, but the U. S. dredge *Gamma*, in charge of Assistant Engineer William Gerig, was used in dredging across and around the point of the sand bar on the lines indicated on the map submitted herewith, which shows the conditions before any dredging was done, at the close of the dredging, and afterwards.

The dredge arrived at the site of the work October 22, began dredging on the 23d, and operated continuously until December 2, forty days; length of cuts made, 35,065 feet; average depth of cuts, 10.2; average length of cut dredged each day, 877 feet.

The dredging was done at a low stage of the river, which gradually changed from 2-foot stage October 22, when dredging began, to -1 foot stage when dredging operations ceased.

No assistance was derived from the current in keeping the cut open while the dredging was in progress; on the contrary, there was a decided tendency to fill, especially where the cut extended around the under side of the bar, necessitating a second and third dredging to keep the cut open.

Soundings were taken over ranges 12, 13, 13½, 14, 14½, 15, 15½, 16, 16½, and 17 on October 25 at a 2-foot stage; on December 2 at a -1-foot stage; on January 6 at a 14-foot stage, which was the minimum of a sudden drop from a 20-foot stage to which the river had risen, and on February 28 at a 10½-foot stage, after the river had fallen from a 28.4-foot stage on February 15.

Below is given for comparison the depth on a part of each of these sections, beginning at the bar end of the section and extending out a distance of 1,000 feet into the river.

	Number of range.									
	12.	13.	13½.	14.	14½.	15.	15½.	16.	16½.	17.
October 25, 1901	10.7	10.3	9.0	6.3	6.4	11.4	59.7	61.2	43.0	25.9
December 2, 1901	12.0	13.2	14.2	7.7	11.1	11.9	55.1	57.4	42.3	26.0
January 6, 1902	14.0	15.1	16.3	12.8	13.0	12.3	44.4	60.1	53.4	33.0
February 28, 1902....	19.0	15.2	17.6	14.8	14.1	16.1	37.4	42.8	36.6	31.1

116 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

An examination of the map will show that a general scouring away off the top of the bar is shown from range 12 to range 17 by the survey of January 6, and a reduction of channel area along the Louisiana shore. In the survey of February 28 this scouring away of the upper part of the bar is more marked from ranges 12 to 15½ than in the previous survey, but from ranges 15½ to 17 there had been a fill on the bar side and a slight shifting of the deep water toward the revetment on the Louisiana side.

After each successive rise in the river the tendency will be to move the point of impact of the main current on the revetment farther down, and this part of the river will assume more nearly its normal condition.

The head of the revetment work will thus be relieved from the severe strain to which it has been subjected during the past few years at high stages by the transfer of the main point of attack farther down, and as a consequence the activity of the large eddy formerly existing at high stages on the Louisiana side between ranges 50 and 104 will be reduced, if not altogether destroyed.

TOWING STONE.

The last of the stone towing was completed on May 4 and the boats taken out of service.

In order to save the expense of rehandling, as well as to reduce the repairs to the barges, which rapidly deteriorate when lying up unloaded, 22 loaded barges, containing 7,940 cubic yards of stone, were held over in the fleet until needed for repairs at Lake Providence, where it was used in repair work.

No stone was towed from the United States quarry on Little Red River during the season.

The cost of the towing from this quarry in previous seasons was:

	Per cubic yard.
Season of 1893.....	\$0.655
Season of 1894.....	.6425
Season of 1895.....	1.96
Season of 1897.....	.859
Season of 1901.....	.617

PLANT.

The amount expended on repairs to plant during the past season was \$6,113.51. Only barely sufficient work was done to patch up the barges for the season's work. No extensive needed repairs were undertaken on account of lack of funds, and as a consequence a large expenditure will be needed the present season to put the plant in condition for service. This, it is estimated, will amount to \$35,000. The amount expended for repairs to plant the previous season was \$34,697.56.

The number of material barges of the first class now belonging to the Third district is 12; second class, 14; third class, 5. Of these not more than 12 can be considered safe for towing stone, even after being repaired; the others are only fit for light towing, such as handling brush and poles.

If any extensive revetment work is to be undertaken, additional plant will be needed. At least ten new material barges, two mattress barges, and a new steamboat will be required in order to provide two revetment parties with adequate plant for economical operations. The new steamer is needed to replace the steamer *Emma Etheridge*, which sank on December 13, 1901.

The estimated cost of additional plant required is as follows:

Ten new material barges, 30 by 120 by 6 feet hold, of wood	\$35,000
Two mattress boats, 160 by 32 by 6 feet hold	11,500
One new steel hull steam towboat, similar in size and power to one already belonging to Third district, 140 by 30 by 6 feet hold	45,000
Total	91,500

Plans for these boats are being prepared.

The survey quarterboat No. 19 was sunk on August 21 by picking up a snag, which passed through the forward rake into the cabin while in tow of the steamer *Medar* with the survey party, at Cordell's landing (522 L).

The boat was afterwards raised, brought to Greenville, docked, and repaired. The opportunity was taken to make other needed repairs at the same time. Nearly all the instruments and records were recovered.

The damage done to the boat by sinking and by raising was breaking off guards, racking of cabin, loss of doors and windows, and damage to roof and partitions. The cost of repairs made was \$459.31.

The steamer *Emma Etheridge* sank on December 13, while making the turn to come into the chute above the fleet, about 300 yards from the shore, by striking a submerged log upon which the boat now rests. The boat was under full headway at the time. A hole was torn in her bottom extending diagonally across from side to side. The hole is from 2 to 4 feet wide and about 20 feet long. The boat sank in a few minutes after striking the obstruction.

An effort was made to raise the boat by passing chains underneath and lifting her by the aid of a barge on each side; but this was found impracticable without great expense, on account of the position of the log on which the boat had settled. Considering the fact that the boat was more than 20 years of age, built of wood, and after raising would require a new hull and other extensive repairs, and that the river had risen nearly to the roof of the cabin, it was decided to be more economical to abandon the boat.

The wreck was afterwards sold at public auction to a wrecking company for \$460. The cost of caring for the floating property and other plant during the year, exclusive of repairs, was \$22,072.72.

On account of excessive charges made by the owner of the property for the use of the front on which the fleet had been moored since January, 1890, it was decided to move the fleet. The use of the front belonging to the Southern Railway, about a mile farther from Greenville, was secured free of cost, and early in June the fleet and all property was moved to the new location.

The old location was afterwards rented by the city of Greenville for ten years and offered to the United States free of charge for fleet purposes. On account of being nearer to Greenville and possibly other advantages, such as facilitating the procuring of labor, proximity to railroad, telegraph, and telephone communications, and the fact that the former location was preferable on account of better water at low stages and freedom from dangers of a caving bank, the offer of the city was accepted. The fleet and other property was moved back to its former location during the latter part of July, where it is at present moored.

Cost of repairs to plant, third district, improving Mississippi River, May 1, 1901, to May 1, 1902.

Number or name.	Cost.	Remarks.
Steamer—		
Arthur Hider	\$554.12	General repairs.
Emma Etheridge	494.73	Do.
Vedette	541.76	Do.
Meter	612.67	Do.
Tug Parker	398.72	Do.
10 quarterboats	973.45	Do.
2 mattress boats	53.39	Do.
Carpenter shop No. 78	103.45	Do.
Machine shop No. 222	111.10	Do.
Store boat No. 138	45.81	Do.
40 barges	747.27	Do.
Dredge Menge	3.42	Making estimate for repairs.
Floating dry dock	296.88	Machinery overhauled.
Grader No. 1	82.26	General repairs.
Grader No. 77	11.13	Machinery overhauled.
Pile driver No. 49	22.70	Lower seams calked.
Levee surveys	114.22	Making high-water gauges.
Property	146.92	Wire cable oiled; minor repairs during year.
Coal boxes	9.57	Minor repairs.
Pumps	291.86	General repairs.
Surveys	47.06	Sawing stakes.
Miscellaneous repairs	325.07	
Construction	125.95	Repairs to skiffs, etc.
Total.....	6,113.51	

118 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Approximate value of plant belonging to the United States and used in the Third district, improving Mississippi River, May 1, 1901, to May 1, 1902.

Class of property.	Number.	Approximate value.
Steamer Arthur Hider, with outfit	1	\$32,111.00
Steamer Vedette	1	3,281.00
Steamer Meter	1	2,660.00
Tug Parker	1	2,660.00
Mat boats Nos. 26, 27, and 188 (old)	3	6,000.00
Mat boats Nos. 28 and 29	2	7,623.00
Headquarter boat No. 31	1	2,660.00
Quarter boats	14	10,053.00
Store boat No. 138	1	719.00
Hydraulic graders Nos. 1 and 3	2	8,029.00
Hydraulic grader No. 77	1	1,350.00
Floating dry dock	1	7,623.00
Barges, square.	16	9,450.00
Do.	14	18,387.00
Do.	12	27,754.00
Stern dock	1	
Skiffs	6	
Boats, calking	4	60.00
Carpenter shop and outfit	1	2,260.00
Machine shop and outfit	1	8,000.00
Office furniture		250.00
Surveying instruments		1,370.00
Total	83	146,000.00

The average number of men engaged in the service of care of and repairs to plant was 31.

The average daily cost for subsistence for employees engaged in care of and repairs to plant was 36.1 cents.

Very respectfully,

ARTHUR HIDER,
United States Assistant Engineer.

Capt. CHARLES L. POTTER,
Corps of Engineers, U. S. Army.

REPORT OF MR. GEORGE C. THOMAS, SUPERINTENDENT OF CONSTRUCTION.

GREENVILLE, Miss., May 7, 1902.

SIR: I have the honor to submit the following report of repairs to revetment at Lake Providence, La., during the season of 1901-02:

The work sustained the following damage during the past high-water season:

From ranges 84 to 98 a general lowering of the subaqueous work by scour and the complete destruction of the upper bank work between ranges 88 and 98 by caving. This is a downstream extension of the break that occurred during the December rise of the season before, which was evidently not fully covered by the repairs made at that time.

From ranges 104 to 106 total loss of upper bank work, the primary cause of which is believed to have been the return flow of the water from the levee borrow pits through a slough leading into the river at this point.

From ranges 118 to 124 the lowering of the shore edge of the mattress by scour and the consequent loss of the upper bank work by caving.

The original project for repairs comprised the construction of 1,700 feet of standard fascine mat and the regrading and repaving of the upper bank where broken. To this there was subsequently added the construction of 1,344 squares of pocket mat necessary for a shore connection.

The working plant was assembled, party organized, and moved on the work October 24, operations beginning the following day.

MATRESS CONSTRUCTION.

The first tow of material was received October 29, and the construction of mat No. 1 began on the 30th.

Number and dimensions of mats constructed were as follows:

	Squares.
Channel mat No. 1, 495 by 300 feet.....	1,485
Channel mat No. 2, 989 by 300 feet.....	2,967
(Total linear feet channel mat, 1,484.)	
Pocket mat No. 1.....	164
Pocket mat No. 2.....	522
Pocket mat No. 3.....	100
Pocket mat No. 4.....	188
Pocket mat No. 5.....	232
Pocket mat No. 6.....	138
Total mat built.....	5,796

The channel mats were sunk to cover the defect between ranges 84 and 98.

Pocket mats Nos. 1, 2, and 3 were sunk in front of the minor breaks to insure a connection with the original mat. Pocket mats Nos. 4, 5, and 6 were sunk between ranges 84 and 98 to complete the shore connection with channel mats Nos. 1 and 2.

GRADING.

Grader No. 1, with single crew, was put in service October 26 and completed the work December 7. Amount graded, 1,650 linear feet, making an average of 44.6 feet per day.

The rate of progress on this work was considerably below the average, a fact due entirely to defective hose, which necessitated a reduction of pressure from 160 to 120 pounds, giving a very inefficient stream over long slopes and in stiff material.

The usual gullying occurred where banks were composed exclusively of sand. These were filled in and slopes dressed to a uniform surface by means of shovels.

The cost per linear foot of completed slope was: Grading, \$0.967; dressing, \$0.837; total, \$1.804.

BANK PAVING.

This work was begun December 2 and completed February 6, with a total of 2,070 squares. Paving constructed exclusively of Little Red River stone laid from six to ten inches thick, depending upon the locality and exposure to attack.

Minor repairs consisted of resloping and repaving the numerous small breaks in the upper bank work, caused by wave action and the passage of surface water over the slope.

Material.—Brush and poles were furnished under contract by Hunter & Frey, of Memphis, Tenn., same being loaded on Government barges at Eggs Point, Miss., and Sterling, La.

Stone was procured from Government quarries on Little Red River, in Arkansas, during the spring of 1901; 7,940.33 cubic yards retained on barges at fleet and 2,892.29 cubic yards reloaded by Government force from the reserve on bank.

The supply of material was at all times fully up to the requirements of the force employed.

Labor.—At no time since my connection with the work has labor been so scarce as during the present season. The local supply of colored labor, usually so plentiful in this work, was only slightly in evidence, and but for the importation of white labor from Memphis the small amount of work projected could not have been completed in advance of the annual high water.

GENERAL CONDITION OF WORK.

Aside from the damage just repaired, the remainder of the work appears in good condition.

The Longwood bar is gradually moving down, throwing the water against Stack Island, where cutting is in progress from the head of the island down to a point nearly opposite the present head of the revetment.

The principal point of attack on the work is still above the salient at range 114, though indications point to a gradual transfer to the lower end of the reach. This would obviate the necessity for an upstream extension of the work, but would doubtless result in a further lowering of the subaqueous work below range 84.

This work was constructed in 1895 and consists principally of old-style woven mats, experience with which does not warrant the belief that they will withstand attack unless reenforced.

The repairs were completed February 7, and the outfit returned to Greenville.

120 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Cost per unit of different kinds of work.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Channel mat.....squares..	4,452	\$5,800.74	\$2,257.86	\$18,329.82	\$26,388.42	\$5.92
Pocket mat.....do.....	1,344	1,902.80	740.59	5,216.33	7,859.72	5.84
Paving bank.....do.....	2,070	2,642.78	1,028.61	11,591.77	15,263.16	7.37
Hydraulic grading.....linear feet..	1,650	1,021.67	212.75	463.95	1,698.37	1.03
Slope dressed.....do.....	1,650	995.44	387.44	.....	3,382.88	.84
Towing.....	.....	2,621.85	699.99	2,121.46	5,443.30	.....
Minor repairs.....	.....	308.89	118.28	271.68	698.85	.....
Superintendence.....	.....	1,245.00	90.62	.....	1,335.62	.....
Property purchased.....	.....	.....	.....	.....	548.99	.....
Sundries.....	.....	.....	.....	.....	84.32	.....
Memphis office.....	.....	.....	.....	.....	2,023.37	.....
Total.....	.....	16,534.17	5,536.14	37,995.01	62,722.00	.....

Material expended per square of channel mat.

[4,452 squares.]

Material.	Quantity.	Per square.
Brush.....cords..	6,339.6	1.424
Poles.....do.....	176.5	.089
Stone.....cubic yards..	3,661.6	.800
Wire strand:		
1-inch.....pounds..	17,228.0	3.867
1-inch.....do.....	7,964.0	1.789
1-inch.....do.....	18,682.0	3.051
1-inch.....do.....	27,067.0	6.084
Silicon bronze wire.....do.....	2,842.0	.638
Galvanized wire, No. 12.....do.....	8,603.0	1.909
Staples.....do.....	500.0	.112
Spikes.....do.....	400.0	.089
Clips, Magnolia.....number..	700.0	.157

Material expended per square of pocket mat.

[1,344 squares.]

Material.	Quantity.	Per square.
Brush.....cords..	1,915.6	1.424
Poles.....do.....	53.7	.089
Stone.....cubic yards..	1,075.2	.800
Wire strand:		
1-inch.....pounds..	5,628.0	4.188
1-inch.....do.....	8,185.0	6.090
Wire, galvanized, No. 12.....do.....	2,567.0	1.909
Silicon bronze wire.....do.....	860.0	.639
Staples.....do.....	150.0	.111

Amount of stone expended on bank paving, 6,048.64 cubic yards for 2,070 squares, or 2.922 cubic yards per square.

Percentage of cost of different items of work.

Classification.	Amount.	Per cent.
Pay roll.....	\$16,534.17	26.3
Subsistence.....	5,536.14	8.8
Material.....	37,995.01	60.4
Sundries.....	84.32	.5
Memphis office.....	2,023.37	3.2
Property purchased.....	548.99	.8
Total.....	62,722.00	100.0

Very respectfully,

Mr. ARTHUR HIDER,
United States Assistant Engineer.

GEO. C. THOMAS,
Superintendent of Construction.

REPORT OF MR. A. MILLER TODD, SUPERINTENDENT.

GREENVILLE, Miss., May 9, 1902.

CAPTAIN: I have the honor to submit the following report of operations in the Lower Yazoo Levee District for the year ending May 1, 1902:

Extent of district and yardage.—The line of levee extends from the Coahoma-Bolivar county line (367 L.) to a point in Warren County, on Eagle Lake, about 7 miles back of Brunswick Landing (580 L.), all in the State of Mississippi. The line has been lengthened 1,383 feet by a new loop at Fitlers (552 L.), and shortened 90 feet by a slight change of location above Rosedale (398 L.), making the net change of length an addition of 1,293 feet. The total length of levee is now 188.3 miles, average height 13.34 feet. The contents of the levees, as estimated May 1, 1901, was 30,562,029 cubic yards. There have been added during the year by the levee board 1,796,000 cubic yards, no yardage having been added by the United States. Deduct for old levee thrown out by new loop at Fitlers, stations 4026+63 to 4012+80a, 208,700 cubic yards. The levee line at the present time contains 32,150,229 cubic yards.

Construction and maintenance.—There being no appropriation and consequently no allotment of funds to this district to be expended during the fiscal year ending June 30, 1902, the amount of funds on hand was sufficient only to undertake the maintenance of the line. Therefore no construction was undertaken. The project submitted included only the necessary sodding and weed cutting and a complete resurvey of the entire district.

Neither at any time last season nor to date this season has the river reached a stage rendering high-water maintenance necessary, and consequently there have been no repairs due to high water.

Sodding.—There remained some portions of the line where a good mat of sod had not been obtained, situated in short and scattered reaches, mostly above Greenville. It was thought best to undertake this work by day force. A party was organized the latter part of May and work commenced. Sodding was completed on the 5th of June. Following is a statement showing cost of same:

Labor	\$304. 85
Team hire, etc.....	68. 77
Total	373. 62
Number of stations sodded.....	563
Number of squares sodded	24, 110
Cost per station	cents.. 66. 4
Cost per square	do.... 1. 55

Weed cutting.—Proposals for weed cutting on 2,658 stations were opened June 11, 1901. These stations were along reaches where weeds had grown sufficiently to be detrimental to the sod, and the cutting was contracted for at 39 cents per station. On July 11 proposals were opened to cut weeds on all the remainder of the line not covered by the above contract and by the proposed levee-board work. This contract was awarded at 27.9 cents per station. All the work was completed about on contract time. Below is a statement showing cost of weed cutting:

2, 658 stations cut, at 39 cents per station.....	\$1, 036. 62
7, 149 stations cut, at 27.9 cents per station.....	1, 994. 57
9, 807	3, 031. 19
Average cost per station, 30.9 cents.	

Levee board work.—A statement accompanies this report, showing the work done by the Mississippi Levee Board during the year. All of their contracts have been completed. The average cost of work amounted to 14.88 cents per cubic yard, not including engineering expenses. Most of the banquette work undertaken by the Board was constructed to the final grade of 2 feet below 1897 high water, with a 5 to 1 slope on the back. Considerable of their enlargement was to a grade 4 feet above high water of 1897, hence the amount of yardage added by them did not complete the line to the provisional grade of 3 feet above 1897 high water.

SURVEY WORK.

A resurvey of the levee line throughout the entire district was commenced September 23. The object was to run a continuous level line checking all permanent bench marks, resetting where necessary, and completing the line of iron bench

marks 1,000 feet apart, and to secure elevations of both sides of the crown and a complete cross section of the levee every 500 feet or as close as the nature of the ground rendered necessary. All existing high-water mark trees were inspected and a local high-water gauge set on all reliable trees, and gauges were set on newly selected trees at a sufficient number of points so located that a complete high-water profile in detail may be read directly from the gauges. The gauges are 8 feet long, graduated in feet and tenths. The zero of the gauge is 3 feet below the top, and is set at the elevation of the 1897 high-water spike, where one exists; on trees where no spikes exist the zero is given an assumed elevation supposed to be about what the 1897 water reached, or would reach along new loops. The survey was completed on December 19. The following statement shows cost of field work:

Pay rolls.....	\$889. 20
Subsistence.....	196. 07
Team hire.....	51. 25
Material, including benches, gauges, freight, etc.....	198. 35
Total.....	1,334. 87

This amount includes salaries of all permanent employees chargeable to survey, and represents accurately the cost.

Number of miles of levee surveyed.....	188. 3
Number of iron pipe benches set.....	135. 0
Number of high-water gauges set.....	249. 0
Cost per mile, \$7.09.	

After returning from the field the permanent force, when the routine duties of the office would permit, engaged in making up continuous profile, compiling lists of the bench marks, and making copies of same for field use; also making new estimate of yardage required to put the levee line up to a grade 6 feet above high water of 1897 (Commission grade). All the above work has been completed. The profile was made on plate B, transparent profile paper, to a scale of 1 inch=6 feet vertical, and 1 inch=800 feet horizontal, in sheets, each covering a reach of levee of 20,000 feet, for the purpose of obtaining blue-print copies. The profile is completed in all details, and the sheets are bound together, with marginal index, the whole constituting a very handy profile for either office or field use. Three blue-print copies were made, one of which was forwarded to your office. Four copies of "Description and Elevation of all Bench marks" were made, one of which was sent to you. A statement of the estimate to the 6-foot grade is included elsewhere in this report.

Shore lines.—Shore-line surveys have been made at the following points: Waxhaw Front (392-394 L.), Riverton (399-400 L.), Jenkins to Mound Landing (430-435 L.), and Bachelors Bend (474-479 L.). Blue prints showing the result of these surveys have been sent to you.

CHANGES IN BANK LINE.

Parkers to Dennis Landing (367-373 L.).—Caving continues from stations 90 to about 140 at a slightly increased rate. Measurements made in March show that along this stretch the season's caving amounts to as much as 100 feet in places, with a minimum distance to the levee of only a little over 500 feet. Along the balance of the reach no measurements have been made, but from observation the caving seems to have continued throughout at about the same rate as heretofore.

Waxhaw Front (392-394 L.).—The point of maximum caving has moved downstream, thus threatening the levee very little more than last season. The caving continues quite active, however, along the entire reach from stations 1170 to 1287, and it is hardly probable that it will be safe to go longer than the next season without covering this reach with a new levee.

Riverton (399-400 L.).—The caving along this reach has moved down the stream considerably, as expected, leaving the minimum distance to the levee about the same as last year.

Jenkins to Mound Landing Front (430-435 L.).—Slight caving has occurred at various points throughout this entire reach. The bank opposite the threatened portions of the levee is about in the same shape as last year. Active caving occurred opposite station 3300 which, if it continues, will make a considerable loop necessary to cover that point. It impresses the writer from an inspection of all the maps of surveys which have been made in this locality, that the conditions are no worse than heretofore, and that if the middle ground or bar continues to fill up, as it did during the period from January, 1901, to December, 1901, immediate and permanent relief from caving along the entire reach will be experienced before any considerable

amount of levee is seriously threatened. However, if the present slight caving is not entirely checked, it will not be safe and practicable to undertake the final enlargement of the levee along the reach. A considerable new loop would have to be provided, or the caving checked by properly regulated channel works. If it should be decided to protect the bend by the latter means, the work should be undertaken in the near future, to prevent the loss of any of the existing levee line in grading the river bank.

Below Mound Landing the old levee has breached for over half a mile, rendering all the country between the Huntington Short Line and the river subject to overflow in the future.

Bachelors Bend Front (475-479 L.).—There seems to have been a slight decrease in the rate of caving along this front. No caving occurred opposite station 4006, where the bank approaches closest to the levee, leaving this point safe for another season. Active caving continues, however, above and below, and the levee there may become seriously threatened at any time.

Below Greenville.—No shore lines have been run to date. It is known, however, that at Longwood Front (499-502 L.), bend of Island No. 92 (514-516 L.), Homochitto to Baleshed (535-537 L.), and from Duvall to Chotard (568-570 L.) caving has continued with slight variations as to rate of cave and localities about the same as heretofore. In the latter reach caving shows a tendency to work upstream, rendering necessary, probably, a new loop in the near future to cover the levee from stations 4700 to 4760.

Fillers to Shiloh (552-555 L.).—The bank above station 4000 caved very rapidly from April to August, 1901. In August the old levee at the angle, station 3982, had been breached, and the bank was encroaching rapidly toward the short loop built by the levee board in 1901. The levee board, after visiting the spot, decided to construct a new and safe loop. Work was started on same as soon as contracts could be let, and the levee is now completed, rendering the line from stations 3942 to 4012 entirely safe. It was observed during last low water that from about station 4005 to station 4080 the river was shoaling next the Mississippi shore as if a bar were about to form at that point. The bank at Shiloh Landing, and below, opposite stations 4200 to 4243a, continues to cave quite rapidly.

CONDITION OF LEVEE LINE.

The top of the levee for the entire line averages 2.95 feet above the high water of 1897, with a maximum height over one reach of eleven stations (Stops levee) 5 feet above 1897 high water, with full standard section to that grade, and a minimum height over a reach of 250 stations (near lower end of district) averaging 2.2 feet above 1897 high water, with no banquette, 8-foot crown, and steep front slope.

The following statement shows condition of the levee line to date.

	Per cent.
Levee up to or above provisional grade of 3 feet above high water of 1897, standard section.....	57.5
Levee that has been to same grade, etc., as foregoing item, but has not stood to grade, being from 2 to 1.5 feet below provisional net grade	14.1
Levee that has crown up to provisional grade, banquette not up, section otherwise standard	5.7
Levee with crown up to provisional grade, no banquette, section otherwise standard	12.5
Levee with neither crown nor banquette up to provisional grade, and section otherwise deficient	10.2
Total length of levee, 994,249 feet.....	100.0

In regard to levee which have been built to net grade and are now found to stand below that elevation, we must, after comparing the results of the recent survey with former surveys, and knowing beyond the possibility of a doubt that levees now found low were at one time up to and above the gross grade specified in their construction, and have not been cut and worn down by use as roadways, conclude that the low state of the levee is due to one of two things, and possibly to both, i. e., that 10 per cent added to height for shrinkage is insufficient, or the levees are sinking by compressing the foundation or by displacing the material in same.

Since the high water of 1897 the entire line of levee in this district has been either enlarged or newly constructed to a net grade 3 feet above said high water, with 10 per cent added for shrinkage. The survey of last fall shows exactly the present condition of the levee as to height and slopes, and analyzing a few of the conditions

found to exist, we are enabled to discriminate as to which of the above causes seems to be responsible for the present low state of the levee.

First, we find that all levees consisting of a sandy or loamy material; not over 12 feet high, and on good foundations, are standing practically to the same elevation as constructed to, viz, gross grade or net grade with the 10 per cent shrinkage added thereto.

Second, we find that all levees consisting mainly of buckshot or a clayey material, and also not over 12 feet high, stand, in most instances, below net grade, even if on the best of foundations.

Third, we find that if the levees are between 12 and 16 feet high, they stand up to or about net grade, if on good foundation and of a sandy material, but if of buckshot they invariably average from three-tenths to five-tenths foot below the net grade.

Fourth, we find that practically all levees over 16 feet high, unless of a sandy loam and the foundations exceptionally good, have not stood up to the constructed net grade. In timber and on poor foundations, and along reaches where the new slopes are extending into old borrow pits, rendering the river side 2 to 4 feet higher than the land side, the levee has gone down. The buckshot reaches are always found lower than the adjacent stations built of sandy material.

From the above we may conclude that where levees are not over 12 feet high (and low reaches are found only where the material consists of buckshot) lack of added shrinkage, at least for that height of levee, is responsible for the low condition. And on larger levees, the height being about the same (reaches of buckshot material being invariably found lower than where of a loamy material), the same reason is ascribable to at least part of the sinking. Also, that along the major portion of the levee line, where the embankment becomes over 12 feet high, there seems to be an amount of bodily sinking of the entire bank, depending on the height of the levee and the character of the foundation. This subject is well worthy of further and systematic study and experiment. It is going to be found, when the final enlargement of the levee is undertaken, that to secure a uniform grade it will be impracticable to construct all the line, regardless of foundation, material, etc., to a fixed height above the flood level, with a stated amount added for shrinkage.

In order that the final grade of the levee may be fairly uniform, the amount of shrinkage added will have to be made variable, or the fixed grade line raised more or less, depending on the local conditions. In making the estimate to the Commission grade (6 feet above 1897 high water) an amount is added to cover a slight raise in the grade on all levees over 12 feet high. The amount of raise was assumed thus: For every foot over 10 feet high add to the grade of all levees 12 feet high and over one-tenth of a foot; this increase to be added only to enlargement and new levees. In case of enlargement the slope opposite to the side on which it is placed will be full 3 to 1, but the front or long slope will be made little less than 3 to 1, calculating a 3 to 1 slope using the extreme fill, less the amount added to the grade line. In case of new levees the slopes on both sides are made a little less than 3 to 1, as above. When the levee settles the slopes will become 3 to 1, as it is observed that in all instances where levees have sunk the slopes have flattened.

The above method, I think, will satisfactorily provide for the sinking on ordinary reaches. On all buckshot levees the shrinkage allowance should be increased to at least 20 per cent.

ESTIMATE FOR CONTINUED CONSTRUCTION.

The following estimate gives the work to be done in order to build the levees in the district to the provisional grade (3 feet above 1897 high water) with standard section:

Stations.	Miles below Cairo.	Kind of work.	Yardage.
<i>Above Greenville.</i>			
0-260	368 L.	Topping	26,000
a 1020-1060	380 L.	} do	33,000
1250-1540	395 L.		
a 1900-2240	403 L.	do	28,000
2683-2720	417 L.	Banquette	41,000
a 2710-2775	419 L.	Enlargement	
a 3810-3972	460 L.	do	31,000
a 3972-4030	475 L.	Topping	
a 4030-4150	476 L.	Enlargement	38,000
4209-4289	477 L.	Banquette	

a Reaches which have once been up to the provisional grade, but now stand under net grade.

Stations.	Miles below Cairo.	Kind of work.	Yardage.
<i>Below Greenville.</i>			
a 100-200	480 L.	Topping	23,000
a 660-790	493 L.	Enlargement	62,000
a 843-1000	495 L.	Topping	12,000
a 1060-1180	495 L.	Enlargement	80,000
a 1320-1480	500 L.	Banquette enlargement	98,000
1346-1730	500 L.	Banquette	41,000
1730-2108	505 L.	Topping	
1960-2020	505 L.	Banquette	3,000
2310-2380	531 L.	Banquette and banquette enlargement	60,000
2572-2880	540 L.	Enlargement	85,000
3800-3942	553 L.	Banquette	70,000
4012-4215	560 L.	do	125,000
4405-5230	568 L.	Enlargement	85,000
4751-4924 a	569 L.	do	130,000
4887-5230	574 L.	do	75,000
5230-5586	574 L.	Banquette	84,000
Total			1,235,000

a Reaches which have once been up to the provisional grade, but now stand under net grade.

The chief engineer of the local levee board informs me that there will be no funds available for levee board work during the next season. Therefore, to complete the levees to a grade 3 feet above the high water of 1897 will require the expenditure of the following amount:

1,235,000 cubic yards of earthwork, at 16 cents	\$197,600
Engineering expenses and repairs, 10 per cent	19,760
Total	217,360

Below is submitted a table showing the new work, to cover levees threatened by caving banks, which present indications point to as being necessary within the next few years. It would not be practicable to undertake the enlargement of the old levee to the ultimate grade along the reaches specified unless the caving banks were materially checked. Estimate to grade 3 feet above 1897 high water.

Locality.	Miles below Cairo.	Approximate estimate.
		<i>Cubic yards.</i>
Above Australia	367-370 L.	700,000
Waxhaw	392-395 L.	750,000
Jenkins	432-436 L.	850,000
Above Greenville	476-477 L.	150,000
Carolina to Skipwith	516-528 L.	487,000
Duval	567-569 L.	150,000
Total		3,087,000

Following is an estimate of yardage required to construct the levee to a grade 6 feet above the high water of 1897 (Commission grade), with standard section:

<i>Enlargement.</i>		
	Cubic yards.	Cubic yards.
Embankment	11,144,575	
Stumps, spurs, road crossings, etc.	557,085	
Increase for sinking	1,845,700	
		13,547,360
<i>Banquette.</i>		
Embankment	1,459,320	
Stumps, etc.	72,835	
		1,532,155
Total enlargement and banquette		15,079,515
Add for new loops		3,000,000
Grand total		18,079,515

126 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The expenditure of Government funds in this district is given in detail in accompanying statement,^a the aggregate amounts being as follows:

	Amount.	Per cent.
Engineering, mapping, etc.....	\$4,182.77	46.9
Surveys.....	1,335.37	15.0
Repairs.....	3,404.31	38.1
Total.....	8,922.45	100.0
Charges from Memphis office.....	5,214.11	
Total expended by Lower Yazoo levee district.....	14,136.56	

The following statements accompany this report:

Statement of expenditures.^a

Statement of rainfall at Greenville, Miss., during the year.

Statement of levee construction by Mississippi Levee Board.

Respectfully submitted.

A. MILLER TODD, *Superintendent.*

Capt. CHAS. L. POTTER,
Corps of Engineers, U. S. Army.

Rainfall at Greenville, Miss., from May 1, 1901, to May 1, 1902.

Month.	1901-1902.	Mean, 1886-1901.	Month.	1901-1902.	Mean, 1886-1901.
1901.	Inches.	Inches.	1902.	Inches.	Inches.
May.....	5.68	3.84	January.....	2.58	5.12
June.....	1.22	4.10	February.....	3.07	4.29
July.....	2.23	4.46	March.....	7.89	5.75
August.....	2.52	3.58	April.....	3.11	4.15
September.....	4.59	2.79	Total.....	42.35	47.70
October.....	.85	2.15			
November.....	3.69	3.72			
December.....	4.92	3.75			

Table showing levee construction by the Mississippi State Levee Board May 1, 1901, to May 1, 1902.

[E.=Enlargement. B.=Banquette. T.=Topping. N.=New. S.=Spur. R. C.=Road crossing.]

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per yard.	Extras paid.	Total expended.	Kind of work.
641-862.....	378 L.	81,618	81,618	Cents. 13.70	\$774.82	\$11,956.49	B.
1150-1184.....	380 L.	27,139	27,139	14.125	76.30	3,909.68	B.
1220-1250.....	390 L.	3,977	3,977	34.125	10.80	1,367.95	T.
1184-1220.....	395 L.	45,569	45,569	10.80	161.00	5,082.45	B. and N.
1305-1380.....	398 L.	37,556	37,556	12.94	50.10	4,909.84	B.
1512-1594.....	400 L.	105,183	105,183	11.73	374.25	12,712.22	B.
1647-1843.....	405 L.	22,906	22,906	13.40		3,069.40	B.
2129-2179.....	414 L.	164,825	26,376	13.48		6,354.92	E. and B.
2233-2413.....	415 L.	108,123	108,123	13.74	79.00	14,935.10	B.
2390-2564.....	417 L.	84,834	84,834	19.40	137.00	16,594.80	B.
2554-2653.....	421 L.	67,710	67,710	11.99		8,118.43	B.
2854-2992.....	432 L.	71,731	14,153	9.45	287.88	2,481.68	B.
2992-3120.....	434 L.	1,583	1,583	35.00		554.05	T.
3172-3185.....	435 L.	70,477	70,477	18.90		15,826.60	E. and B.
3219-3250.....	436 L.	57,522	57,522	35.00		9,744.22	E.
3272-3330.....	445 L.	290,452	129,967	16.94		20,669.04	E. and B.
3371-3410.....				14.73			
3502-3552.....				12.90			

^a Omitted.

Table showing levee construction by the Mississippi State Levee Board May 1, 1901, to May 1, 1902—Continued.

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per yard.	Extras paid.	Total expended.	Kind of work.
				<i>Cents.</i>			
3812-3915 ^a	460 L.	74,951	74,951	18.00		\$13,491.18	B. T. S.
3980-4150.....	475 L.	96,269	96,269	11.73	\$301.87	11,594.22	B.
115 ^b	480 L.	1,100	1,100			173.60	R. C.
225-550.....	482 L.	64,052	64,052	16.00	99.93	10,348.25	B.
763.....	492 L.	273	273	20.50		55.96	R. C.
790-843.....	493 L.	41,606	41,606	16.00		6,656.96	E.
976-1070.....	495 L.	44,706	9,414	10.00		1,462.28	B.
1022-1059.....	495 L.	1,258	1,258	25.00		314.50	T.
2108-2310 ^c	515 L.	16,324	16,324	12.50		2,040.50	B.
2580-2572 ^c	525 L.	17,387	17,387	14.625		2,542.85	B.
3174-3191.....	537 L.	29,134	14,874	12.00		2,041.56	N.
3146-3385.....	538 L.	122,133	122,133	12.20		14,900.22	E. and B.
3602-3787 ^d	550 L.	103,256	103,256	12.20		12,597.23	E. and S.
3942-4026.....	552 L.	308,538	308,538	13.43	433.75	41,870.33	N.
4216-4407.....	555 L.	82,677	5,804	11.50	223.65	2,169.23	B.
4407-4580.....	560 L.	69,587	13,531	12.74		2,795.08	E. and B.
4580-4750.....	565 L.	103,222	21,437	11.99		4,041.20	E.
Total.....			1,796,900			267,381.98	

^a Topping is on old levee below angle at station 3916. Spur joins old levee 1,000 feet below angle at station 3916.

^b Done by day work.

^c For 1 foot increase in grade on United States work, 1900-1901.

^d Spurs at Stations 3551 and 3600, upper and lower ends of United States levee of 1897.

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER.

GREENVILLE, Miss., May 10, 1902.

CAPTAIN: I have the honor to submit the following report of operations in the Upper Tensas levee district from May 1, 1901, to May 1, 1902:

The limits of the district, together with a brief description of the location of the different systems, will be found in the Annual Report of the Chief of Engineers for 1900, pages 4854 and 4855, in which the only change to be noted is an extension of the Arkansas River system from stations 732 to 785 on the Dry Bayou location.

The total length of the levee in this district on May 1, 1901, was 184.53 miles, containing 28,175,496 cubic yards, of which about 21,487,174 cubic yards had been placed by the United States and the remaining 6,688,322 cubic yards by the local boards. During the year there have been added by the United States 199,684 cubic yards and by local boards 741,651 cubic yards, making a total for the year of 941,335 cubic yards. During the season 9,554 feet of new line have been constructed in Arkansas and 11,168 feet in Louisiana, throwing out 20,365 feet of old levee containing 537,113 cubic yards, leaving the total length of the levee line in the district May 1, 1902, 186.7 miles, containing 28,579,718 cubic yards, 21,686,858 cubic yards being credited to the United States.

The deductions made in levees for yardage thrown out by new loops are as follows:

Local name.	Miles below Cairo.	Stations.	Length.	Cubic yards.
<i>In Arkansas.</i>				
Lucea loop.....	427-8 R.	388+21-483+50	9,529	341,940
<i>In Louisiana.</i>				
Cabin Teale.....	584 R.	3607-3638+06	3,106	48,162
Duckport loop.....	588 R.	3714+93-3762+62	5,543	83,403
Killarney loop No. 1.....	594 R.	3936+65-3945	925	19,766
Martin loop.....	598 R.	4414+16-4426+78	1,262	43,842
Total.....			10,836	195,173

128 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

At the close of the fiscal year 1901 the following work was under contract:

Arkansas:	Louisiana:
Stations 732-785, Arkansas River.	2497-2570 (562 R.).
Stations 2562-2740 (488 R.).	2570-2651 (563 R.).

Stations 732-785, Arkansas River extension, Stone & Stansell, contractors, completed February 6, 1902, and final estimate given on February 8.

Stations 2562-2740, Sunnyside Front enlargement, J. B. Lewis, contractor, was completed March 6, and final estimate given March 12, 1902.

Stations 2497-2570 Willow Point banquettes, M. P. Erwin, contractor, was completed May 10, and final estimate given May 14, 1902.

Stations 2570-2651, Willow Point banquettes, J. K. Jeffries & Sons, contractors, lapsed April 30, 1902.

During the season the following pieces of work were put under contract, bids for same being opened June 6, 1901. These contracts cover what is known as Lucca loop:

Stations.	Miles below Cairo.	Awarded to—	Price.	Kind of work.
388+21-413.....	427 R.	Ben. Talley	<i>Cents.</i> 15.99	New.
413-438.....	427 R.	Jeffries & Son	18.5	Do.
438-462.....	428 R.	J. B. Lewis	20.9	Do.
462-483+75.....	428 R.	Jeffries & Son	22	Do.

As was stated in the last annual report, the failure of the river and harbor bill left only \$25,000 that could be expended in levee construction in this district, which amount was applied to the construction of the Lucca loop, and arrangements made with the Tensas Basin and Chicot County levee boards to furnish the balance of funds required. For detailed statement of the disposition of funds see table accompanying this report.

Considerable trouble was experienced on account of scarcity of labor, which caused delay, necessitating an extension of contract time on first and second sections. With that exception the work was completed in good shape as follows:

First section, Stations 388+21-413, January 22, 1902.

Second section, Stations 413-438, February 13, 1902.

Third section, Stations 438-462, December 31, 1901.

Fourth section, Stations 462-483+75, January 3, 1902.

Repair work.—The repair work done during the season consisted of redressing and resodding slopes where they had become badly washed by heavy rains, and resodding where the sod had been destroyed. The United States having no funds for this class of work, the Desha County board proposed to furnish the necessary funds to repair the levees on their front. The work was begun, but had to be abandoned in the early part of the season on account of the extreme dry weather. One hundred and eighty-four stations were repaired at a total cost of \$521.25, making an average cost of \$2.88 per station.

Weed cutting.—Bids for weed cutting on the entire line in Arkansas were opened June 25. George R. Lacy was awarded the contract for the entire Amos Bayou line, Stations 0-268 and Stations 0-1600 of main line, at 29 cents per station.

The bids for the remaining part of the line were rejected, being considered too high, and contracts were made with parties living along the line to cut and remove the weeds from Stations 1600 to 4210. This work was completed September 27. Total cost of cutting and removing weeds from the 4,393 stations was \$1,222.78. Average cost per station, 28.73 cents. In Louisiana the weed cutting was done by the Fifth Louisiana Levee Board. The board bought four mowing machines and the necessary stock to work them, together with complete camp outfit, which was put in charge of a foreman, who went over the entire line, cutting all weeds where necessary. There were cut 2,275 stations, at a total cost (cost of outfit not included) of \$780.62. Average cost per station, 34.31 cents.

ARKANSAS RIVER LEVEES.

On pages 4857 and 4858 of the Annual Report of the Chief of Engineers for 1900 will be found a brief description of the conditions and needs of the Arkansas River levees and the relation of this line of levees to the Mississippi River system. No new contracts having been made during the season for the further extension of this line, the gap of 6.05 miles between the lower end of the Arkansas River system and the main

line of levee at Boggy Bayou remains as it was in the last report. The safety and general good of the district demand the closing of this gap as rapidly as possible.

SURVEYS.

A general survey was made of the levees from Station 0 on Amos Bayou line to the lower end of the district in Louisiana. This survey was made for the purpose of running a continuous line of levels over the top of the levee connecting with all high-water gauges, iron pipe bench marks, and stone line bench marks, renewing old gauges, and adding a sufficient number of new gauge positions to give a correct high-water slope, as near as practicable, at all points along the levees, and cross-sectioning the line to a 6-foot grade. To do this a cross section was taken every 500 feet, or oftener where necessary, for enlargement to a grade 6 feet above and banquette 2 feet below high water of 1897. These notes are now being worked up and the district profiles will be brought up to date as soon as possible.

CAVING BENDS.

Cypress Bend (426 R.).—No location has been made of the shore line in this bend since the construction of the Lucca loop, but a large percentage of the front levee has caved off since the completion of the above loop.

Upper Leland (470 R.).—Caving continues on the upper side of the Leland neck. A recent reconnaissance of the shore line shows that the maximum caving along the stretch from Stations 2100 to 2147 since 1897 has been about 1,000 feet, bringing it to within 300 feet of the levee. In addition to this, the levee from Station 2100, on the upper side, around to Station 2442, on the lower side, is of a very weak section, which, in view of the fact that it would have to be thrown out, has never been brought up to the 1897 grade except by topping, and is dangerously near the river bank and very much exposed to wave wash on the lower side of the neck. Therefore the only permanent solution of the matter is the construction of the short line that has been recommended for some years, and is now respectfully urged. This short line as proposed begins at Station 2047, on the upper side of the neck, and runs straight across to Station 2442, on the lower side, being 83 stations in length, containing 350,000 cubic yards, estimated for a grade 3 feet above the 1897 high water.

Mathews Bend (507-510 R.).—The citizens of Grand Lake, situated at the foot of this bend, have been somewhat apprehensive in regard to the safety of their little town due to the inclination of the bank to cave at their present landing. The shore line of the entire bend was run out in March, and it was found that in the lower half of the bend there was no material change from the position of the shore line since 1898, and it is not considered that the tendency to slough, in the vicinity of the landing, is sufficiently manifest to warrant any anxiety whatever. In the upper half of the bend the survey shows considerable change. The maximum caving was found to be about 450 feet since August, 1898, opposite Station 3550. The levee at this point, however, is still about 1,400 feet back from the river bank.

Wilsons Point (531 R.).—The shore line at Wilsons Point was located in February and the maximum distance from levee to shore was found to be about 300 feet, having caved back about 500 feet during the last nine years. The greater part of the caving, however, has taken place in the last three years. A new loop will probably be needed there next season.

CONDITION OF LEVEES WITH REFERENCE TO 1897 HIGH WATER.

In Arkansas.—Extension Arkansas River system, total length 14.8 miles: Stations 0-655 (12.4 miles) topped to 2½ feet above 1897 high water. Stations 655-783 (2.4 miles), new levee, constructed to 3 feet above 1897 high water.

Mississippi River system, total length 83.3 miles, Costello Gin to State line:

72.2 per cent 3 feet above 1897 high water.

19.7 per cent 2 to 2½ feet above 1897 high water.

8.1 per cent topped to 3 feet above 1897 high water.

28 per cent of line has banquette; 72 per cent of line has none.

In Louisiana.—Length of line from Arkansas State line to lower end of district, 88.6 miles.

7.4 per cent of line 1 to 1.8 feet above 1897 high water.

31.3 per cent 1.9 to 2.6 feet above 1897 high water.

59.3 per cent 2.8 to 4.5 feet above 1897 high water.

2 per cent 6.3 to 6.6 feet above 1897 high water.

57.5 per cent of line has banquette, 42.5 per cent has none.

130 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Estimated yardage to bring the entire line to a grade of 3 feet above high water of 1897, with standard section.

Stations.	Enlarge- ment.	New levee.	Ban- quette.	Total.	Remarks.
In Arkansas.					
0-783 a	Cu. yds. 365,490	Cu. yds.	Cu. yds. 198,009	Cu. yds. 563,499	Enlargement of Arkansas River levees. Extension Arkansas River levees. (Amos Bayou. Main line.
783-1087		1,187,429	153,287	1,340,716	
0-269	189,459		1,057,143	1,246,602	
0-4210					
Total	554,949	1,187,429	1,408,439	3,150,817	
In Louisiana.					
0-4619	242,339		883,403	1,125,742	
Grand total..	797,288	1,187,429	2,291,842	4,276,559	

^aStations 655-783 built to 3-foot grade without banquette.

Estimate for ultimate Commission grade.—This is based on the average height of new Commission grade at White River and Arkansas City, Arkansas City and Greenville, Greenville and Lake Providence, and Lake Providence and Vicksburg, and applying these averages to the local high water along the line between these respective points, thus giving the following approximate estimates in Arkansas and Louisiana:

IN ARKANSAS.

Stations.	Kind of work.	Cubic yards.	Price.	Total cost.	Remarks.
0-655	Enlargement.	1,066,015	<i>Cents.</i> 18.8	\$200,410.82	Arkansas River levees. Do. Do. Do.
655-783	do	184,000	18.8	34,592.00	
783-1087	New	1,826,044	17.0	310,427.48	
0-1087	Banquette....	688,635	12.0	82,636.20	
		3,764,694	.....	628,066.50	
0-269	Enlargement.	5,103,599	18.8	959,476.61	(Amos Bayou line. Main line. Covers stations 600-900. Covers stations 2047-2442.
0-4210		1,249,279	16.0	199,884.64	
600-816	New	452,453	16.0	72,392.48	
2047-2131	do	1,778,721	12.0	213,446.52	
0-4210	Banquette....				
Total ..		8,584,062	.....	1,445,200.25	

IN LOUISIANA.

0-4619	Enlargement.	6,566,040	18.8	\$1,234,415.52	
0-4619	Banquette....	2,301,971	12.0	276,236.52	
Total ..		8,868,011	.....	1,510,652.04	

SUMMARY.

	Cubic yards.
Extension and enlargement of Arkansas River levees	3,764,694
Arkansas main line	8,584,062
Louisiana	8,868,011
Total cubic yards	21,216,757
Total cost	\$3,583,918.79

The estimates show that there is still required 4,276,559 cubic yards to bring the entire system up to the 3-foot grade with standard section. Of this amount 365,490 yards will be required for the enlargement of the Arkansas River levees from stations 0 to 783; 1,187,429 cubic yards for the extension of this levee to station 1,087 on Cypress Creek, opposite station 81 on the main line and 351,296 cubic yards for banquette for the above stretches of levee from Red Fork to Cypress Creek, leaving 2,372,344 cubic yards to cover the main line in Arkansas and Louisiana.

ARKANSAS RIVER LEVEE IMPROVEMENT.

In addition to the levee work done in the Upper Tensas levee district, there is considerable work being done, under the supervision of the United States engineers, on the Arkansas River levees in the Red Fork levee district. This district has a frontage of about 14 miles, extending from the Lincoln County line to the beginning of the Government levee just below Red Fork. The board is disposing of some of its State lands, from which it expects to realize something like \$40,000, all of which will be expended on the improvement of its levees. A contract has been made by the local board with Stone & Stansell to place 200,000 cubic yards or more (the quantity being governed by the amount of available funds), at 12½ cents per cubic yard, beginning at the upper end of the district and working continuously toward the lower end. On May 1, 91,324 cubic yards had been placed. The levee is being constructed to a section 3 feet above the highest known water, with 5-foot crown, slopes 2 to 1. This section, owing to the short duration of the Arkansas River floods, is believed to be of greater relative strength than the section used on the Mississippi River levees. If the board can realize \$40,000 on the sale of their lands, it is estimated that they will be able to cover about 11 miles of their line. One and a quarter miles of the lower end have already been enlarged or covered by new loops to the standard section of 8-foot crown and 3 to 1 slopes, thus putting the line in fairly good condition with the exception of about 1.6 miles.

HIGH WATER OF 1902.

The highest water reached this season was 36 feet on the Greenville gauge on March 30. No expenditures were made for high-water protection except an expenditure of \$141.50 to protect the end of the Arkansas River extension levee with a revetment of sacks of earth to prevent caving by the cross current of water running into the back country.

The maximum gauge readings are given for each year from 1897 to 1902, inclusive, from Cairo to Vicksburg, as follows:

Station.	1897.	1898.	1899.	1900.	1901.	1902.
Cairo.....	51.6	49.8	46.2	39.2	43.2	42.1
Helena.....	51.8	49.1	46.8	38.1	41.6	39.6
Arkansas City.....	51.9	51.1	48.8	39.2	43.3	41.4
Greenville.....	46.8	46.2	43.0	33.8	37.4	36.0
Lake Providence.....	44.5	44.4	41.7	33.0	36.5	35.0
Vicksburg.....	52.5	49.4	47.3	38.0	41.5	41.2

MISCELLANEOUS.

To avoid repetition, I will simply refer to the Report of the Chief of Engineers, 1900, pages 4861-4863, where there will be found a brief discussion of such subjects as bench marks, drainage, protection from wave wash, preparation of foundations, telephone service, damages caused by hogs and public roads on levees, and the resources of the several levee boards.

The principal features of improvement in the district that would materially affect the revenue for levee construction are the works done and those contemplated by the St. Louis, Iron Mountain and Southern Railway Company and the Valley Telephone Company. The railway company has been actively engaged for the past twelve months in making preliminary and location surveys for a delta division of their system, extending from West Memphis, Ark., to Clayton, La., a distance of about 272 miles. A good part of this line has been permanently located, and from Trippe, Ark., to the Louisiana line, a distance of about 40 miles, is now under contract for construction. This line comes into the protected district from the north, just below Red Fork on the Arkansas River, crosses the unprotected region back of the gap between the two systems, crosses the Amos Bayou line near the head of the main system, and runs thence through the entire district, touching at Trippe, Lake Village, Lake Providence, Stamboul, and Tallulah. The location of this line is the result of the confidence that has been established in the worth of the levee system as a means of protection, and a belief that the two systems would soon be connected and generally improved until the delta would be secure against overflows.

The revenues accruing from this enterprise, together with the increased revenue due to the development of the hitherto virgin lands of this most fertile valley, will

132 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

be a very substantial and gratifying encouragement to the levee interests, and should be a stimulant to the Commission's purpose, already formed, to connect the Arkansas River levees with the Mississippi River system at Boggy Bayou.

The Valley Telephone Company will very soon lay a submarine cable across the river at this point, and is rapidly completing a general telephone system in Arkansas that will be of valuable service to the levee district, especially during dangerous flood periods.

Inclosed with this report will be found the following:

List of expenditures of the United States.^a

Statement of work done and funds expended by the Red Fork, Desha County, Chicot County, Tensas Basin, and Fifth Louisiana Levee boards and the State of Louisiana.

Table showing cost of construction.

Labor statement.

In conclusion, I wish to thank the local levee boards for prompt and efficient cooperation and my assistants generally for faithful and thorough performance of duty.

Respectfully,

E. C. TOLLINGER,
United States Assistant Engineer.

Capt. CHAS. L. POTTER,
Corps of Engineers, U. S. Army.

Levee work in Upper Tensas levee district in Arkansas and Louisiana, May 1, 1901, to May 1, 1902.

[N.=New; E.=Enlargement; B.=Banquette.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
<i>In Arkansas.</i>													
782-785.....	Ark. R.	Stone & Stansell..	169,788	41,223	1,497	1,085	709	38	58	14.214	14.5	150	N.
888+21-413 ^a	427 R...	Ben Talley	109,587	109,587	4,620	3,664	2,126	33	51	15.990	18.3	250	N.
413-438 ^a	427 R...	Jeffries & Son	123,781	123,781	6,930	4,872	3,140	25	38	18.500	18.8	250	N.
438-462 ^a	428 R...	J. B. Lewis.....	119,414	119,414	6,762	4,397	2,760	28	43	20.90	19	250	N.
462-483+75 ^a	428 R...	Jeffries & Son	115,091	115,091	6,704	4,419	2,644	26	43	22	19.5	250	N.
2562-2740.....	488 R...	J. B. Lewis.....	65,963	33,499	1,543	1,117	780	30	43	13.70	11.3	125	E.
<i>In Louisiana.</i>													
2497-2570.....	562 R....	M. P. Erwin	29,153	4,857	228	139	107	31	41	11.90	9.6	250	B.

^aLucca Loop, built by the United States and the Tensas Basin and Chicot County levee boards.

Respectfully submitted.

E. C. TOLLINGER,
United States Assistant Engineer.

GREENVILLE, MISS., May 7, 1902.

^aOmitted.


THIRD DISTRICT, IMPROVING MISSISSIPPI RIVER.

SCALE IN MILES.




LEGEND


Bank Lines shown according to Surveys of 1892-1894.

Changes in bank line 1894-1902 shown thus 


River distances indicate miles below Cairo.

Levees (controlling line) indicated thus 

" (old) " " " 

" with banquettes " " " 

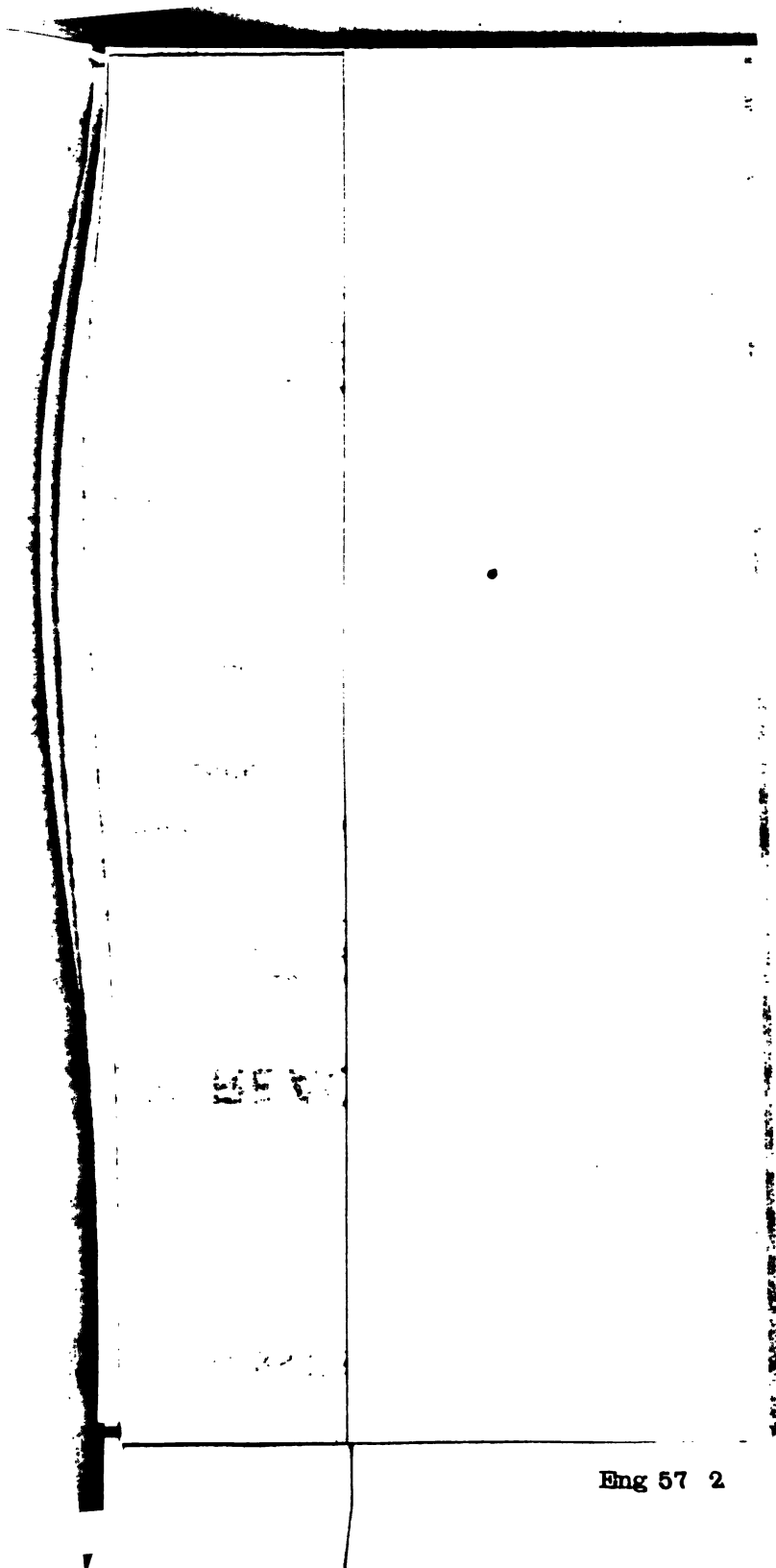
Numbers along levee indicate stations of 100 feet

Bank Revetment indicated thus 

TO ACCOMPANY ANNUAL REPORT MAY 1902.

Chas. P. Butler
CAPT. OF ENGRS.

[REDACTED]





Statement of work done in the Upper Tensas levee district in Arkansas and Louisiana by the Desha County, Chicot County, Tensas Basin, and Fifth Louisiana levee boards and the State of Louisiana, from May 1, 1901, to May 1, 1902.

WORK DONE IN ARKANSAS.

	Cubic yards.	Cost.
Desha County levee board:		
Right of way, stations 388+21-483+75, Lucca loop		\$1,399.65
Repair work		591.25
Miscellaneous expenses		992.00
Tensas Basin levee board:		
Stations 388+21-483+75, Lucca loop	307,754	59,968.46
Chicot County levee board:		
Stations 388+21-483+75, Lucca loop	39,514	7,760.77
Repair work and right of way		125.00
Miscellaneous expenses		1,815.35
Total	347,268	72,642.48

WORK DONE IN LOUISIANA.

State and Fifth Louisiana levee boards:		
Enlargement and new levee	394,383	\$54,964.06
Weed cutting and sodding		780.62
Total	394,383	55,744.68

RECAPITULATION.

Desha County levee board		\$2,982.90
Tensas Basin levee board	307,754	59,968.46
Chicot County levee board	39,514	9,691.12
State and Fifth Louisiana levee boards	394,383	55,744.68
Total	741,651	128,387.16

Work done above Red Fork, Arkansas, by the Red Fork levee board.

	Cubic yards.	Cost.
Enlargement:		
Stations 0-121	91,324	\$10,273.95
Stations 625-658	11,484	1,435.50
Stations 683+75-708	13,095	1,767.82
Miscellaneous expense		822.20
Total	115,903	14,299.47

Cost of work done by the United States in the Lower Yazoo Levee district from 1882 to May 1, 1902.

Stations.	Miles below Cairo.	Contractor.	Cubic yards.	Cost.
Levee construction, 1882 to May 1, 1901			16,404,548	\$2,465,594.56
Levee construction, May 1, 1901, to May 1, 1902.				
2108-2310	510 L.	W. M. Bates	9,452	a 1,631.34
2380-2572	526 L.	H. F. Watkins	12,480	a 2,439.48
Total levee construction, May 1, 1901, to May 1, 1902			21,932	4,070.82
Total levee construction, 1882 to May 1, 1902			16,426,480	2,469,655.38
High-water protection, repairs, and engineering expenses, 1882 to May 1, 1901				430,328.45
High-water protection, repairs, and engineering expenses, May 1, 1901, to May 1, 1902				14,762.46
Total high-water protection, repairs, and engineering expenses, 1882 to May 1, 1902				445,090.91
Total cost to May 1, 1902				2,914,746.29

a Work finished prior to May 1, 1901, but paid for afterwards.

134 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Cost of work done by the United States in the Upper Tensas levee district from 1882 to May 1, 1902.

Stations.	Miles below Cairo.	Contractor.	Cubic yards.	Cost.
Levee construction, 1882 to May 1, 1901.....			21,283,308	\$3,485,727.15
Levee construction, May 1, 1901, to May 1, 1902:				
<i>Arkansas—</i>				
782-785.....	Ark. R.	Stone & Stansell.....	59,821	10,056.11
388+21-413.....	427 R.	Ben Talley.....	36,110	5,774.00
413-438.....	427 R.	Jeffries & Son.....	81,351	5,800.01
438-462.....	428 R.	J. B. Lewis.....	25,870	5,406.79
462-483+75.....	428 R.	Jeffries & Son.....	27,273	5,999.97
2562-2740.....	488 R.	J. B. Lewis.....	44,907	6,440.73
			225,332	39,477.61
<i>Louisiana—</i>				
2497-2570.....	562 R.	M. P. Erwin.....	17,172	a 2,186.04
Total levee construction, May 1, 1901, to May 1, 1902.....			242,504	41,663.65
Total levee construction, 1882 to May 1, 1902.....			21,525,812	3,527,390.80
High-water protection, repairs, and engineering expenses, 1882 to May 1, 1901.....				729,556.06
High-water protection, repairs, and engineering expenses, May 1, 1901, to May 1, 1902.....				17,651.56
Total high-water protection, repairs, and engineering expenses, 1882 to May 1, 1902.....				747,207.62
Total cost, 1882 to May 1, 1902.....				4,274,598.42

a Work finished prior to May 1, 1901, but paid for afterwards.

Financial statement.

ASHBROOK NECK.

July 1, 1901, balance unexpended	\$9.39
June 30, 1902, amount expended during fiscal year	9.39

Amount that can be profitably expended in fiscal year ending June 30, 1904. 70,000.00

GREENVILLE, MISS.

July 1, 1901, balance unexpended	\$2.20
June 30, 1902, amount expended during fiscal year	2.20

Amount that can be profitably expended in fiscal year ending June 30, 1904. 50,000.00

LAKE PROVIDENCE REACH.

July 1, 1901, balance unexpended	\$5.59
Amount allotted by Mississippi River Commission during fiscal year from appropriation by sundry civil act approved June 6, 1900	50,000.00

June 30, 1902, amount expended during fiscal year	50,005.59
	40,505.02

July 1, 1902, balance unexpended	9,500.57
July 1, 1902, balance available	9,500.57

Amount that can be profitably expended in fiscal year ending June 30, 1904. 25,000.00

MISSISSIPPI RIVER COMMISSION.

135

PLANT, THIRD DISTRICT.

July 1, 1901, balance unexpended	\$22,765.08
Amount allotted by Mississippi River Commission by transfer from other works, third district, improving Mississippi River, from appropriation by sundry civil act approved June 6, 1900.....	15,000.00
	<hr/>
June 30, 1902, amount expended during fiscal year	37,765.08
	<hr/>
July 1, 1902, balance unexpended	27,237.18
July 1, 1902, outstanding liabilities	10,527.90
	<hr/>
July 1, 1902, balance available	2,500.00
	<hr/>
July 1, 1902, balance available	8,027.90
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904.	100,000.00

STONE, THIRD DISTRICT.

July 1, 1901, balance unexpended	\$7,469.63
June 30, 1902, amount expended during fiscal year	1,964.43
	<hr/>
July 1, 1902, balance unexpended	5,505.20
July 1, 1902, outstanding liabilities	200.00
	<hr/>
July 1, 1902, balance available	5,305.20
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904.	50,000.00

LOWER YAZOO LEVEE DISTRICT.

July 1, 1901, balance unexpended	\$58,990.10
Less amount transferred by Mississippi River Commission to other works in third district, improving Mississippi River, during fiscal year	32,000.00
	<hr/>
June 30, 1902, amount expended during fiscal year	26,990.10
	<hr/>
July 1, 1902, balance unexpended	13,760.77
July 1, 1902, outstanding liabilities	13,229.33
	<hr/>
July 1, 1902, balance available	1,500.00
	<hr/>
July 1, 1902, balance available	11,729.33
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904.	500,000.00

UPPER TENNESSEE LEVEE DISTRICT.

July 1, 1901, balance unexpended	\$71,753.73
Less amount transferred by Mississippi River Commission to other works in third district, improving Mississippi River, during fiscal year	8,000.00
	<hr/>
June 30, 1902, amount expended during fiscal year	63,753.73
	<hr/>
July 1, 1902, balance unexpended	53,395.98
July 1, 1902, outstanding liabilities	10,357.75
	<hr/>
July 1, 1902, balance available	1,200.00
	<hr/>
July 1, 1902, balance available	9,157.75
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904.	500,000.00

SURVEYS, GAUGES, AND OBSERVATIONS.

July 1, 1901, balance unexpended	\$2,156.76
June 30, 1902, amount expended during fiscal year	2,156.76
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1904.	5,000.00

136 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Contract in force in the Upper Tensas levee district June 30, 1902, with name of contractor, date of approval, of beginning work, and of expiration.

Levee stations.	Miles below Cairo.	Contractor.	Date of approval.	Date beginning work.	Expiration of contract.
2570-2651....	563 R.	J. K. Jeffries & Sons.....	Mar. 20, 1901	.....	Apr. 30, 1901

APPENDIX 4.

REPORT OF MAJ. G. McC. DERBY, CORPS OF ENGINEERS, UPON OPERATIONS IN FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1902.

COLONEL: I have the honor to submit the following report upon the work of the Fourth district, Mississippi River improvement, for the period from June 1, 1901, to June 1, 1902:

The Fourth district, Mississippi River improvement, extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, a distance of 452.8 miles by river.

The works include the improvement of the harbors at Natchez and Vidalia, Mississippi and Louisiana; improvements at the junction of the Mississippi, Red, and Atchafalaya rivers; improvement of the harbor at New Orleans, La.; bank protection in Bondurant Chute; bank protection in Kempe Bend, and the construction, repair, and maintenance of a portion of the levee system of the district.

HARBORS OF NATCHES AND VIDALIA.

The project for this work contemplates the construction of a levee on or near the axis of Cowpen Neck, to prevent the flow of water across the Neck during high stages of the river, and the construction of about 16,000 lineal feet of bank revetment in Giles Bend; estimated cost, \$541,300. The object of the proposed work is to prevent the formation of a threatened cut-off at Cowpen Neck, which would cause the destruction of the town of Vidalia, much injury to the water front and landings at Natchez, and increased caving of the banks above and below, with consequent destruction of expensive parts of the levee system.

The amount expended upon this project to June 1, 1901 was \$495,162.19, and there remained a balance of \$47,089.85.

A hydrographic survey, finished in January, showed the work of previous seasons in apparent good order.

During the current year mats were sunk on the ends of spurs 9, 10, and 11, so as to maintain their connection with shore; the continuous revetment at the lower end of the bend was prolonged upstream a distance of 1,100 feet, making its total length 5,200 feet. The gap of 250 feet, purposely left in this revetment to allow a salient point to wear back to the general line of the revetment, was reduced to 115 feet; and two mats were sunk in the bight of a large pocket above the revetment to check its recession so as to also bring it in the general line of the revetment next season.

During the year 499,435 square feet of mats were constructed and towed from the willow bars above and placed in a continuous revetment protecting the bank abreast of that portion of the levee on Cowpen Neck, the destruction of which was threatened this season. This mattress work cost \$0.06196 per square foot; the upper bank pavement of concrete constructed in situ cost \$0.06051 per square foot. The total field cost of the revetment constructed this year amounts to \$27.81 per running foot of bank.

The details of this work and its cost are fully set forth in the appended report of my assistant, Mr. H. S. Douglas. Sketches are herewith showing the location of the work done and the rate of caving of the bank.

The levee on Cowpen Neck is still intact, but it is probable that the revetment will have to be prolonged next season or the levee will be breached by the caving bank before or during the following high water.

In this connection it should be observed that the revetment work in Giles Bend has not yet reached the narrowest part of Cowpen Neck, and that a further appropriation is needed to prolong the revetment past this narrow part of the neck; until *this* is done the money already expended will have produced no useful effect.

The amount expended from June 30, 1901 to June 30, 1902, derived in part from the appropriation for improvement of harbors at Natchez and Vidalia, Miss. and La., and in part from an allotment made by the Mississippi River Commission for "Prevention of Cut-Off at Giles Bend," is distributed as follows:

Office expenses, main office.....	\$2, 857. 16
Other administrative expenses	1, 495. 98
Construction of revetment (hired labor):	
Materials	\$4, 687. 44
Wages.....	17, 633. 28
Subsistence	6, 377. 87
	<hr/> 28, 698. 59
Manufacture of concrete ballast	5, 547. 45
Surveys	1, 193. 79
Repairs to plant.....	3, 623. 90
Care of plant.....	2, 265. 89
New plant.....	1, 151. 91
Miscellaneous.....	255. 18
	<hr/>
Total	47, 089. 85

Money statement.

IMPROVING HARBORS AT NATCHEZ AND VIDALIA, MISS. AND LA.

July 1, 1901, balance unexpended	\$40,346. 25
June 30, 1902, amount expended during fiscal year	40, 346. 25

{ Amount that can be profitably expended in fiscal year ending June 30, 1904.....	150, 000. 00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

PREVENTION OF CUT-OFF AT GILES BEND, MISSISSIPPI.

July 1, 1901, balance unexpended	"\$6, 743. 50
June 30, 1902, amount expended during fiscal year	6, 743. 50

JUNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, LOUISIANA.

A detailed description of the difficulties in this vicinity, which the improvements were designed to rectify, will be found in the annual report for 1892. In general terms these difficulties consist in the tendency of the Atchafalaya River to enlarge and in the silting up of Old River, the only navigable connection between the Mississippi and the Red and Atchafalaya rivers.

The works heretofore contemplated had in view the following objects:

To check the enlargement of the Atchafalaya and limit its outlet capacity by a system of low relief dams or sills.

To separate Red River from the Atchafalaya during low water, and up to a 10-foot stage, by means of a low dam at the west end of Turnbolls Island, which would deflect Red River around the upper side of the island.

To supply a new outlet for the Red by cutting a canal across Carrs Point and obstructing the lower end of upper Old River.

Red River would thus always be a tributary of the Mississippi at low stages and the Atchafalaya an outlet, while the conditions at high stage would remain about the same as they were originally.

The plan also contemplated maintaining low-water navigation through lower Old River, if practicable, by dredging or otherwise, pending the completion of the above system of works.

Owing to insufficient funds, work on all parts of this project, except the first and last, has been suspended for many years, and experience having demonstrated that the channel in Lower Old River can be kept open with the dredge at moderate expense, the improvement of the channel of Upper Old River has been definitely abandoned, narrowing the project to checking the enlargement of the Atchafalaya and maintaining a navigable channel through Lower Old River.

* Balance unexpended July 1, 1901, as stated in previous report, \$6,743.25, difference due to allowance of 25 cents in expenditures.

138 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The usual annual survey around the sill dams was omitted this season on account of scarcity of funds. The high water of 1901 not having been an extreme one, however, and the current at ordinary stages having been principally from the Mississippi into the Atchafalaya, there has been little or no scouring around the dams this year, and on the contrary a considerable deposit, so that the bed of the river above the upper dam is now about level with the top of the dam.

As experience has shown that a single extraordinary high water like that of 1897 will remove all of this deposit and continue the attack on the original bed of the river above and below the dams, it has been thought necessary to widen the foundation mats above and below each dam, and lay the foundation mat for a new dam immediately above the existing upper dam. As much of this work as the funds available would permit has been completed during the year, the upper sill has been widened both above and below, and the lower sill along its lower edge only. In each case the widening mats were 150 feet wide, and extend across the river from low-water mark to low-water mark.

These mats contain 352,200 square feet, and were sunk in place at a total field cost of 5.9964 cents per square foot, including the cost of extra ballast placed upon the mat above the upper dam.

A sketch is herewith, showing their location and the details of the work, and its costs are set forth in the accompanying report of Mr. H. S. Douglas, Assistant Engineer.

The gauge at Red River Landing did not fall below 1.3 during the season, so less than the usual amount of dredging became necessary in Old River. It is estimated that 57,000 cubic yards of material were dredged and deposited in the stream alongside the cut made by the dredge. The dredge was kept in Old River from August 9 to August 27, when the condition of the channel was such as to make dredging no longer necessary. A navigable channel with a depth of 5½ feet or more was maintained throughout the season.

The details of this work are set forth in the accompanying report of Mr. L. E. Lion, Junior Engineer.

The amount expended from June 30, 1901, to June 30, 1902, is \$33,521.70, distributed as follows:

Office expenses, main office.....	\$3, 245. 86
Other administrative expenses	1, 026. 05
Repairs to sill dams (hired labor):	
Materials	\$4, 306. 37
Wages.....	8, 588. 76
Subsistence	4, 368. 47
	<hr/>
	17, 263. 60
Manufacture of concrete ballast	4, 807. 30
Repairs to plant.....	1, 602. 97
Care of plant.....	1, 421. 41
New plant	501. 93
Miscellaneous.....	19. 83
Dredging Old River:	
Materials	\$246. 60
Wages.....	1, 064. 12
Subsistence	606. 61
	<hr/>
	1, 917. 33
Repairs to plant.....	884. 89
Care of plant.....	118. 73
New plant	130. 32
Administrative expenses.....	581. 48
	<hr/>
	3, 632. 75
 Total	 <hr/>
	33, 521. 70

Money statement.

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

July 1, 1901, balance unexpended	\$33, 521. 70
June 30, 1902, amount expended during fiscal year	33, 521. 70
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1904.....	50, 000. 00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

NEW ORLEANS HARBOR.

The approved project for the improvement of New Orleans Harbor contemplates the protection of the banks in all of the caving bends by means of sloping submerged spur dikes, made mostly of brush and stone, resting upon wide foot mats and spaced at intervals varying from 400 to 1,600 feet, as circumstances may require, with continuous mattress revetment covering the intervals where necessary. The ultimate cost is not estimated.

At the close of the last working season the work completed comprised about 400 feet of mattress protection at the head of Carrollton Bend; five spur dikes at Southport, with continuous mattress revetment in the intervals between the upper four spurs; two spur dikes in the Greenville Bend; six spur dikes in the Gouldsboro Bend; in the Third District Reach sixteen spur dikes had been completed, a continuous revetment constructed between spurs 1 and 2, and a mattress 150 by 200 feet placed contiguous to the foundation mattress of spurs 2, 3, 3½, 4, and 4½.

The funds available June 30, 1901, have been expended under the following project:

"There are five localities in New Orleans Harbor where more or less revetment work has been done during past years—the Third District Reach, Algiers Point, Gouldsboro Bend, Greenville Bend, and Southport. I have recently had all these localities surveyed, and find the revetment work generally in good order, and there has been no great amount of caving in the harbor during the past year.

"As the Orleans Levee Board has undertaken extensive work in the Third District Reach, with a view to protecting the caving bank there, and this experiment has been authorized by the Secretary of War, it would not seem to be advisable at present to prolong the revetment in that locality below Lizardi street, where it now terminates.

"In Greenville Bend there are two isolated spurs, built in 1889, about 950 feet apart. They have held the points against which they were built, but the rest of the bank has continued to recede until these two spurs project so far out into the stream that it is doubtful if they can ever form a useful element in any comprehensive scheme for the general protection of the bend. The distance from the edge of the bank to the levee is so much greater than in other localities and the value of the property behind the levee so much less that the protection of this bend does not seem to be a matter of great urgency as compared with the other localities where protection works have been begun.

"At Algiers Point we have a system of six spurs at intervals of 450 feet, and at Gouldsboro, farther up in the same bend, another system of six spurs, built from 1884 to 1888, at intervals varying from 500 to 950 feet. The gap between these two systems of spurs is about 2,700 feet and the width of batture is so narrow and the value of the property on the bank of such value that the additional spurs necessary to make this system continuous from Algiers Point to Gouldsboro should be built this season. I would, therefore, recommend that five spurs, at intervals of about 450 feet, be placed in this locality, and that an additional spur be placed between Spurs 4 and 5 of the Gouldsboro system, where the interval of 950 feet is too great to prevent erosion of the bank between spurs.

"These spurs should consist of two cribs of the usual construction, placed upon a foundation mat 150 feet wide and 400 feet long; the lower crib to be 6 by 24 by 300 feet, and the upper one 6 by 16 by 350 feet.

"At Southport the unrevetted portion of the bank has become much steeper than it was when surveyed in 1894; erosion has been much more severe in deep water than near the surface. This is particularly noticeable at a depth of about 60 feet. The prevailing depth at the foot of the slope is 120 feet below low water, and the upper half of this slope is very much steeper than the lower half. On the average, the lower half of the slope has a base of about 149 feet, while the upper half has a base of only 84 feet. There are two points where the bank is standing with a slope as steep as 1 to 1 for a height of more than 100 feet, and for long distances the slope is as steep as 2 to 3.

"In spite of this extraordinary steepness of the bank, caving has not been at all active at Southport during recent years, which is the more remarkable when we have in mind the fact that the last great cave at Algiers Point occurred when the bank had a slope as flat as 1 to 2. But the probabilities are that the bank at Southport is already in a state of unstable equilibrium, being held up by its cohesion only, and that at any time it may let go and slip off in immense masses. On the other hand, it is quite possible that many more years may elapse before this takes place.

"Experience at Southport has shown that spur dikes, even when built of enormous proportions and at intervals as small as 500 feet, will not check erosion between the

spurs; it has in every instance been found necessary to build in the end a continuous mattress revetment. When the bank is as high and as steep as it is at Southport, spurs of the type heretofore used at that locality have to be built with such enormous dimensions that they have no merit on the score of economy, and their weight is such that in the course of time they lose much of their height by excessive settling.

"On the other hand, there is no certainty that a continuous revetment will keep the bank from caving, for there is nothing about a mattress revetment that will restore stability to a bank which has already lost it.

"The lower half of the slope, which now has on the average a base of 149 feet for a height of 60 feet, has still doubtless sufficient inherent stability to stand if protected from further scour; and if this were done and the upper half of the bank were left unprotected, it would in the course of time recede until the whole slope had a base suitable for its height, when the upper half of it could also be matted.

"At the rate at which the upper bank recedes, about 6 feet per annum on the average, it would take about ten years for the upper half of the bank to acquire a base equal to that which the lower half now has, and the danger is that in the meantime caving may occur in such large masses as to wreck the mattress protecting the lower half of the slope. If the upper bank caves in comparatively small masses, the mattress below would probably not be injured and the upper bank would ultimately assume a reasonably flat slope. If experience shows the contrary tendency, the remedy would lie in dredging away the top of the bank so as to grade it in terraces to a slope of about 1 to 3 down to a depth of about 30 feet below mean low water. There is space enough between the edge of the bank and the levee to permit this dredging to be done without injury to the latter, and I estimate that the work can be done with the dredge *Ram* for about \$3 per running foot of bank. As this is a considerable item of expense, I would recommend that the dredging be not undertaken until experience has made manifest the necessity for doing so.

"In view of the facts outlined above, I would recommend that with the funds remaining available, after providing for the Gouldsboro Bend work, mattresses 250 feet wide, of the usual New Orleans type, be sunk side by side on the lower half of the slope of the bank at Southport for a distance of 1,800 feet above the existing revetment and for the same distance below Spur 5, holding in reserve the sum of \$10,000 with which to grade the upper part of the bank should it prove to be necessary."

The above project was duly approved and all the work contemplated in it has been completed except the 1,800 feet of mattress work above the Southport wharf, which had to be postponed on account of the necessity of using the plant at Giles Bend.

Two large caves having taken place at Southport, one of which carried away the shore end of Spur No. 5, it was decided to undertake grading the upper part of the subaqueous bank. An attempt was made to do the work with the hydraulic dredge the *Ram*, but owing to the stiffness of the clay and the presence of large cypress stumps in considerable numbers the work could not be advantageously done with the *Ram*; at least not without extensive alterations. The work has since been advertised twice for completion with a clam-shell dredge, but as yet no contract has been made, the high prices bid being regarded as prohibitory. Efforts in this direction are still being made.

The project for the improvement of New Orleans Harbor was adopted in 1882 and as yet but a small portion of the work has been begun.

For the past ten years it has been annually reported that \$300,000 per annum could be profitably expended on the work, but the appropriations have averaged less than \$55,000 per annum. The work contemplated consists entirely in the protection of the caving banks so as to give permanency to the shore line to permit the construction of wharves, elevators, and other shipping facilities. The levee line is generally very close to the caving banks, but no great anxiety has been felt on this account because the banks within the city limits have never been known to cave at high water, and a cave taking place when the river is within its natural banks involves of course no danger of an overflow.

A cave recently took place at Shannon, about 4 miles below Baton Rouge, which seems to be both instructive and suggestive. In this case the levee was 200 feet from the edge of the bank. The river had risen to 29.40 feet at Baton Rouge April 19, the highest record for the year, and on April 24 it had only fallen to 28.70 feet, when at 4 p. m. of that date the shore in front of the levee at Shannon began to subside, and by daylight the next morning a mass had caved off measuring 600 feet parallel to the river and 240 feet at right angles; the levee was breached, the outer slope was carried away, and for a distance of 100 feet the crown of the levee was entirely gone, the break extending some distance down the back slope. A survey was

promptly made, and the water offshore was found to be about 70 feet deep (soundings reduced to low water) and the steepest part of the slope of the bank still standing above and below the cave had a height of 30 feet on a base of 60. In the city of New Orleans the banks are much higher and even steeper.

On inquiry at the office of the State board of engineers, I find that there are records of three other cases where large caves took place during high water—at Ames (opposite New Orleans) in 1884, at Hermitage in 1890, and at Belair in 1892.

I know of no local conditions that make a high-water cave more likely to occur at these localities than at any other locality where the subaqueous bank has become so steep that its base has not the proper relation to its height, so that its natural stability is impaired; in such a case the bank stands in a condition of unstable equilibrium, and is liable to cave at any moment.

In other words, I am of the opinion that the fact that high-water caves have occurred at a few localities, whereas in general caves only occur when the river is within its banks, is an accident of time and not of locality. A cave takes place when it is ripe; it is of course more likely to become ripe when the river has fallen considerably than at or near high water, but it sometimes does become ripe at or near high water, and it is just as likely to do this at one locality as at another.

Consequently no levee located within 200 feet of such a bank can be considered entirely safe, however good a levee it may be otherwise, for there is always the chance of its caving into the river at high water. Of course such a risk would not generally be a great one, since high-water caves are of very rare occurrence and the results of a crevasse are not usually absolutely overwhelming. But I wish to invite attention to the fact that in the city of New Orleans there are many thousand feet of levee located on the edge of such banks as I have described, and we have a population of probably 200,000 people who are living behind these levees on low land, in small one-story frame buildings, so that a sudden crevasse occurring in the levee line of the city at or near high water would probably be most disastrous and accompanied by great loss of life.

It is in my judgment a great mistake to take this risk a year longer than is absolutely necessary, and I would strongly recommend that funds be provided to complete the project for the protection of the banks as promptly as practicable instead of at only one-sixth the rate which has been recommended for the past ten years.

In this same connection I would also lay special stress upon the fact that a continuous mattress revetment applied to such a bank as I have described does not in any degree diminish the danger that I have been discussing; such a revetment stops erosion and prevents the bank from becoming any steeper, but if it is already too steep, as is so generally the case in New Orleans Harbor, there is of course nothing about a mattress revetment that in any degree restores to the bank its stability once it has been impaired. The removal of the top of the bank or the building out of its foot seems to be called for.

The amount expended from June 30, 1901, to June 30, 1902, derived in part from the appropriation for improving harbor at New Orleans, La., and in part from an allotment made by the Mississippi River Commission for improving Mississippi River, allotment for harbor at New Orleans, La., is distributed as follows:

Office expenses, main office.....	\$4,125.14
Other administrative expenses.....	3,843.03
Construction of revetment (hired labor):	
Materials.....	\$18,800.75
Wages.....	26,467.54
Subsistence.....	11,286.67
	<hr/>
	56,554.96
Manufacture of concrete ballast.....	116.14
Surveys.....	418.54
Repairs to plant.....	6,665.75
Care of plant.....	6,190.93
New plant.....	1,801.75
Dredging at Southport.....	1,225.86
	<hr/>
Total.....	80,942.10

Money statement.

IMPROVING HARBOR AT NEW ORLEANS, LA.

July 1, 1901, balance unexpended	\$99,002.24
June 30, 1902, amount expended during fiscal year	78,783.57
July 1, 1902, balance unexpended	20,218.67
July 1, 1902, outstanding liabilities	29.64
July 1, 1902, balance available	20,189.03
<hr/>	
{ Amount that can be profitably expended in fiscal year ending June 30, 1904. .	300,000.00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Money statement.

IMPROVING MISSISSIPPI RIVER, ALLOTMENT FOR HARBOR AT NEW ORLEANS, LA.

July 1, 1901, balance unexpended	\$2,158.53
June 30, 1902, amount expended during fiscal year	2,158.53

REVTMENT IN BONDURANT CHUTE.

An allotment was made by the Mississippi River Commission June 21, 1899, for constructing a revetment in Bondurant Chute to prevent for three years the breaching of the levee on the bank of the chute in front of Lake Bruin.

The amount expended upon this work at the beginning of the fiscal year was \$20,000. A revetment 1,600 feet long had been constructed, containing 120,000 square feet of willow mattress, 30,000 square feet of board mattress, and 75,090 square feet of upper bank pavement of concrete constructed in situ.

When last inspected this revetment was in good order and serving its purpose. It will probably require extension downstream during the coming season.

No work was done during the year, there being no funds available.

KEMPE BEND' REVTMENT.

An allotment for Kempe Bend revetment was made by the Mississippi River Commission March 9, 1899, approved by the Secretary of War March 15, 1899.

This allotment was rendered necessary by the continued caving of the bank in Kempe Bend, threatening to destroy the levee which crosses the Kempe Swamp a few miles below St. Joseph, La. This swamp is very large, unusually low, and covered with a dense growth of timber, so that it is estimated that a properly located new levee across or around it would cost little less than half a million dollars.

A project for the expenditure of this allotment was approved by the Chief of Engineers May 19, 1899. It contemplates a continuous revetment protecting that portion of the bank which is nearest to the levee. The final cost of the work has not been estimated, as it is not known how far the revetment will ultimately have to be extended.

At the beginning of the fiscal year the bank had been matted with a distance of 4,318 feet and paved for a distance of 3,840 feet. The funds available amounted to only \$40,455. On account of the close proximity of the levee, it was thought advisable to hold the funds in reserve as far as possible to make immediate repairs should the revetment be breached again as it was the year before. Fortunately this did not happen and operations were confined to minor repairs, care of plant, and the accumulation of material in readiness for the resumption of work early the coming season. When last inspected this revetment was in apparent good order. It now requires extension both up and down stream.

Experiments have been continued this year in making an exceedingly cheap grade of concrete for ballast, using the least possible amount of Portland cement to consolidate sufficiently well for the purpose the sand and gravel which lie mixed together on some of the river bars in the district. About 8,200 tons of this ballast were made during the year; the cost and details of manufacture are very fully set forth in the accompanying report of Mr. H. S. Douglas, Assistant Engineer. It is believed that improvements in methods and appliances will be made during the coming season which will meet the difficulties developed last year. The cement used last year is

now offered me at \$1.70 instead of \$2.57 per barrel, and it is probable that a further economy can be secured by the use of Puzzolan cement.

The economy to be expected from the use of concrete is not limited to the advantage in the first cost of the material as compared with rock, but is more apparent in the fact that a much less quantity can be made to serve the purpose, particularly in paving the upper bank.

The amount expended from June 30, 1901, to June 30, 1902, is \$21,352.65, distributed as follows:

Office expenses, main office	\$1,228.33
Other administrative expenses	1,585.19
Construction of revetment (hired labor):	
Materials	\$945.63
Wages	78.15
Subsistence	190.10
	<hr/>
Manufacture of concrete ballast	1,213.88
Surveys	4,836.98
Repairs to plant	689.08
Care of plant	3,195.61
New plant	7,935.76
Miscellaneous	531.08
	<hr/>
Total	21,352.65

Money statement.

IMPROVING KEMPE BEND, LOUISIANA.

July 1, 1901, balance unexpended	^a \$43,398.39
June 30, 1902, amount expended during fiscal year	21,352.65
	<hr/>
July 1, 1902, balance unexpended	22,045.74
July 1, 1902, outstanding liabilities	460.15
	<hr/>
July 1, 1902, balance available	21,585.59

PLANT.

The plant of the district now consists of 47 large pieces and has a capacity of about 7,500 linear feet of bank revetment. Six pieces should be replaced this year, the tug *Tilda*, launch *Ruby*, and barges Nos. 5, 8, 9, and 12.

The allotment for plant had been exhausted at the beginning of the fiscal year, and no further allotment could be made, as the river and harbor bill had failed to pass. The cost of taking care of the plant and keeping it in repair has therefore been charged to the various works in progress.

The report of Mr. H. S. Douglas, Assistant Engineer, herewith, contains a detailed statement of the work done for the care and maintenance of the plant during the year.

The amount expended from June 30, 1901, to June 30, 1902, is \$3,787.44, distributed as follows:

Other administrative expenses	\$312.12
Wages	\$2,950.29
Subsistence	60.00
	<hr/>
Care of plant	3,010.29
	<hr/>
Total	3,787.44

Money statement.

PLANT.

July 1, 1901, balance unexpended	^b \$3,787.44
June 30, 1902, amount expended during fiscal year	3,787.44

^a Balance unexpended July 1, 1901, as stated in previous report \$43,398.14; difference due to disallowance of 25 cents in expenditures.

^b Balance unexpended July 1, 1901, as stated in previous report, \$3,786.44; difference due to disallowance of \$1 in expenditures.

144 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

SURVEYS, GAUGES, AND OBSERVATIONS.

The previous allotments for this work had been exhausted at the beginning of the fiscal year and no further allotment could be made, as the appropriation bill had failed.

Surveys were, however, made at Southport, Kempe Bend, and Giles Bend; and the bank lines have been resurveyed in Marengo Bend, Hard Times Bend, Cowpen Bend, and at Shannon, changes having taken place involving the safety of parts of the levee system.

The gauge at Barbre's Landing, at the junction of the Red and Atchafalaya rivers, has been maintained as heretofore.

LEVEES.

For work connected with levee construction and maintenance the district is subdivided into seven levee districts, as follows:

The Lower Tensas levee district, right bank, which extends from the upper limits of the Fourth district, opposite Warrenton, to the mouth of Red River. In this district the levee system is continuous from the upper end to a point 5 miles below Fairview Landing, 131.5 miles by river, leaving about 26 miles unprotected.

The Atchafalaya levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system is continuous in this district.

The Lafourche levee district, right bank, which extends from the head of Bayou Lafourche to New Orleans. The distance by river is 78 miles and the levee system is continuous.

The Barataria levee district, right bank, which extends from New Orleans to the Head of the Passes, 82½ miles. The levee system is continuous down to the Jump, 71.5 miles.

The Homochitto levee district, left bank, created by a resolution of the Mississippi River Commission, November 19, 1894, which extends from the mouth of the Yazoo River to Baton Rouge, 238.5 miles by river. There are as yet no levees in this district, except a few detached lengths built by private parties.

The Pontchartrain levee district, left bank, which extends from Baton Rouge to New Orleans, 123.5 miles. The levees are continuous.

The Lake Borgne levee district, left bank, which extends from New Orleans to the Head of the Passes, 91 miles. The levee system at present only extends to Fort St. Philip, covering 70 miles of the river.

The funds available for levee construction in this district June 30, 1901, amounted to \$78,873.17, being the unexpended balances of the allotments for the preceding year. The levee line has been improved this year by the United States to the extent of 331,679 cubic yards.

The following table shows the variation in the cost of levee building in this district during recent years:

Contracts.

Year.	Cubic yardage.	Cost per cubic yard.	Year.	Cubic yardage.	Cost per cubic yard.
		<i>Cents.</i>			<i>Cents.</i>
1890.....	895,000	19.3	1896.....	4,658,000	10.8
1891.....	1,410,000	21.2	1897.....	1,775,000	10.99
1892.....	908,000	17.8	1898.....	3,592,000	14.12
1893.....	2,142,000	21.2	1899.....	2,465,000	13.6
1894.....	3,589,000	15.0	1900.....	2,735,000	13.23
1895.....	3,414,000	12.3	1901.....	332,000	14.26

The highest gauge reading reached by the river at Vicksburg this year was 41.2; no high-water protection work has been necessary, and the funds reserved for emergency work will now be expended in permanent improvement of the levee line.

The following table shows approximately the condition of the levee line on the completion of this year's contracts:

	Levee districts.					
	Lower Tensas.	Atchafa- laya.	La- fourche.	Pontchar- train.	Barata- ria.	Lake Borgne.
Above high water of 1897:	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>
Less than 1 foot.....	4.59	2.03	1.36	41.32	2.14	0.19
From 1 to 2 feet.....	9.24	2.49	17.84	31.11	28.66	35.67
From 2 to 3 feet.....	27.14	21.13	24.04	14.08	24.32	14.18
More than 3 feet.....	87.64	104.49	38.76	39.11	16.64	21.25
Total.....	128.61	130.14	82.00	125.57	71.66	71.29

The banquettes called for by the standard cross section have as yet only been constructed in a few of the most urgent cases.

No work has been done in the Homochitto levee district, there having been no funds available.

The details of the work accomplished during the year in the other districts are given in the following tables and are further discussed in the accompanying report of Mr. W. E. Knobloch, superintendent of levees.

Fourth district levees, 1901-1902.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
Waterproof Lot 1:							
1	Section 1.....	663	R.	James R. Marlow.....	<i>Feet.</i> 1,100	<i>Feet.</i> 1,000	<i>Feet.</i> 3
2	Section 2.....	663	R.	.....do.....	1,100	1,000	3
3	Section 3.....	663	R.	.....do.....	1,000	900	3
Waterproof Lot 2:							
4	Section 1.....	663	R.	.....do.....	1,000	900	3
5	Section 2.....	663	R.	.....do.....	1,000	900	3
6	Section 3.....	663	R.	.....do.....	998	800	3
Claremont:							
7	Section 2.....	692	R.	Helgason Bros.....	600	500	6
8	Section 3.....	692	R.	.....do.....	800	700	6
Sycamore:							
9	Section 1.....	694	R.	Richard Bland.....	900	900	6
Fish Pond:							
10	Section 1.....	723	R.	Helgason Bros.....	2,370	1,000	3
11	Section 2.....	723	R.	.....do.....	3,100	1,600	3
12	Section 3.....	723	R.	.....do.....	2,500	1,400	3

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
Waterproof Lot 1:									
1	Section 1	<i>Feet.</i> 8	3 to 1	3 to 1	Enlarge- ment.	<i>Feet.</i> 1.8	16.0	Apr. 30, 1901	July 6, 1901
2	Section 2	8	3 to 1	3 to 1	do	2.4	15.8	do	Nov. 5, 1901
3	Section 3	8	3 to 1	3 to 1	do	2.0	15.6	do	Dec. 16, 1901
Waterproof Lot 2:									
4	Section 1	8	3 to 1	3 to 1	do	2.4	16.0	Mar. 26, 1901	Oct. 25, 1901
5	Section 2	8	3 to 1	3 to 1	do	2.0	16.2	do	Sept. 18, 1901
6	Section 3	8	3 to 1	3 to 1	do	2.2	16.1	do	Aug. 8, 1901
Claremont:									
7	Section 2	8	3 to 1	3 to 1	do	5.8	13.3	Feb. 11, 1901	June 1, 1901
8	Section 3	8	3 to 1	3 to 1	do	5.8	13.3	do	July 4, 1901
Sycamore:									
9	Section 1	8	3 to 1	3 to 1	do	4.5	14.7	Dec. 28, 1900	Oct. 28, 1901
Fish Pond:									
10	Section 1	8	3 to 1	3 to 1	do	2.4	12.4	July 1, 1901	Feb. 26, 1902
11	Section 2	8	3 to 1	3 to 1	do	2.4	13.5	do	Dec. 23, 1901
12	Section 3	8	3 to 1	3 to 1	do	2.4	11.6	do	Sept. 26, 1901

146 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Fourth district levees, 1901-1902—Continued.

LOWER TENNAS LEEVE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Waterproof Lot 1:		<i>Cents.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
1	Section 1	14,101.23	15.70	\$2,213.89	5,300	5,500	5,400	Stationary.
2	Section 2	14,113.72	15.70	2,215.85	5,500	5,600	5,550	Do.
3	Section 3	13,259.76	15.70	2,081.78	5,600	5,700	5,650	Do.
	Waterproof Lot 2:							
4	Section 1	12,482.77	15.50	1,934.83	5,700	5,800	5,750	Do.
5	Section 2	12,350.94	15.50	1,914.40	5,800	5,800	5,800	Do.
6	Section 3	12,700.42	15.50	1,968.57	5,800	5,800	5,800	Do.
	Claremont:							
7	Section 2	10,093.39	11.45	1,155.69	12,760	12,760	12,760	Caving.
8	Section 3	13,043.87	11.45	1,493.52	12,760	12,760	12,760	Do.
	Sycamore:							
9	Section 1	14,757.09	13.00	1,918.42	8,800	9,600	9,200	Do.
	Fish Pond:							
10	Section 1	13,835.07	13½	1,919.62	1,550	1,690	1,610	Do.
11	Section 2	14,188.02	13½	1,968.39	1,600	1,820	1,680	Do.
12	Section 3	14,182.64	13½	1,967.84	1,910	2,040	1,920	Do.

ATCHAFALAYA LEEVE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Upper Grand Bay:				<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1	Section 1	808	R.	Israel R. Bobbitt	1,409	200	4.0
2	Section 2	808	R.	.....do	1,500	700	4.0
3	Section 3	808	R.	.....do	1,500	700	4.0

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Upper Grand Bay:	<i>Feet.</i>				<i>Feet.</i>	<i>Feet.</i>		
1	Section 1	8	3 to 1	3 to 1	Enlargement.	2.3	19.3	Sept. 10, 1900	May 17, 1901
2	Section 2	8	3 to 1	3 to 1	.....do	1.6	18.7	.....do	Do.
3	Section 3	8	3 to 1	3 to 1	.....do	2.0	18.3	.....do	Do.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Upper Grand Bay:		<i>Cents.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
1	Section 1	14,925.95	16½	\$2,457.91	1,575	1,800	1,620	Caving.
2	Section 2	15,379.20	16½	2,511.94	1,560	1,680	1,600	Do.
3	Section 3	15,627.96	16½	2,552.57	1,700	1,900	1,800	Do.

Fourth district levees, 1901-1902—Continued.

ATCHAFALAYA LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
1	Devall: Section 3	823	R.	Ernest Hyner	<i>Feet.</i> 900	<i>Feet.</i> 820	<i>Feet.</i> 4.4
2	Cypress Hall: Section 1	823	R.	.....do	900	820	4.4
3	Section 2	823	R.	.....do	800	730	4.4
4	Section 3	823	R.	.....do	600	540	4.4

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.	
1	Devall: Section 3	<i>Feet.</i> 8	3 to 1	3 to 1	Enlargement. .....do .........do .........do	<i>Feet.</i> 3.2	<i>Feet.</i> 19.1	Mar. 10, 1900
2	Cypress Hall: Section 1	8	3 to 1	3 to 1		3.1	19.2	Do.
3	Section 2	8	3 to 1	3 to 1		3.0	21.4	Do.
4	Section 3	8	3 to 1	3 to 1		2.9	22.3	Do.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
				Least.	Greatest.	Average.		
1	Devall: Section 3	14,037.75	<i>Cents.</i> 15.47	<i>Feet.</i> 900	<i>Feet.</i> 1,340	<i>Feet.</i> 1,160	Caving ........do .........do .........do	Nothing done. Do. Do. Do.
2	Cypress Hall: Section 1	15,877.53	15.47	900	1,030	960		
3	Section 2	15,821.24	15.47	1,030	1,120	1,080		
4	Section 3	13,322.23	15.47	1,120	1,230	1,170		

LAFOURCHE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
1	St. James Church: Section 1	902	R.	Hayes Bros	<i>Feet.</i> 1,900	<i>Feet.</i> 1,900	<i>Feet.</i> 4.0
2	Section 2	902	R.	.....do	1,900	1,900	3.9
3	Section 4	902	R.	.....do	1,550	1,550	3.9
4	Odier: Section 2	949	R.	Miss. Lev. Const'n Co. ...	1,900	2,320	3.2
5	Section 3	949	R.	.....do	1,600	2,180	3.3
6	Section 4	949	R.	.....do	1,966	1,810	3.2
7	Starlight: Section 1	953	R.	Robt. McNamara	1,125	1,200	3.2
8	Section 2	953	R.	.....do	1,150	1,006	3.2

Fourth district levees, 1901-1902—Continued.

LAFOURCHE LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
1	St. James Church: Section 1	8	3 to 1	3 to 1	Enlargement.	1.8	13.9	Jan. 31, 1901	June 19, 1901
2	Section 2	8	3 to 1	3 to 1	do	1.7	14.7	do	Aug. 20, 1901
3	Section 4	8	3 to 1	3 to 1	do	2.0	15.3	do	July 30, 1901
4	Odier: Section 2	8	3 to 1	3 to 1	do	1.7	11.3	Aug. 30, 1900	May 13, 1901
5	Section 3	8	3 to 1	3 to 1	do	1.9	11.6	do	Sept. 12, 1901
6	Section 4	8	3 to 1	3 to 1	do	1.8	10.9	do	Sept. 3, 1901
7	Starlight: Section 1	8	3 to 1	3 to 1	do	3.0	13.3	Sept. 7, 1900	Feb. 19, 1902
8	Section 2	8	3 to 1	3 to 1	do	2.7	13.5	do	May 13, 1901

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
1	St. James Church: Section 1	13,459.66	11.14	\$1,499.41	245	330	270	Caving.
2	Section 2	13,568.80	11.14	1,511.36	290	330	310	Do.
3	Section 4	13,882.25	11.14	1,546.48	170	290	195	Do.
4	Odier: Section 2	13,182.92	13.50	1,779.69	183	430	310	Stationary.
5	Section 3	13,234.92	13.50	1,786.71	425	880	575	Do.
6	Section 4	12,960.83	13.50	1,749.71	850	1,300	940	Do.
7	Starlight: Section 1	11,903.42	16.00	1,904.55	382	440	400	Washing.
8	Section 2	11,925.94	16.00	1,908.15	210	465	410	Do.

BARATARIA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
1	Abadie	1,022	R.	John Cleary	Feet. 1,235	Feet. 1,200	3.0
2	Rodey extension	1,038	R.	Michael Cullen	2,238	2,500	2.8

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
1	Abadie	8	2 to 1	6 to 1	New	Feet. 1.4	Feet. 7.8	Oct. 31, 1901	Jan. 23, 1902
2	Rodey extension	8	3 to 1	3 to 1	Enlargement.	1.4	7.2	Sept. 24, 1900	Sept. 18, 1901

MISSISSIPPI RIVER COMMISSION.

149

Fourth district levees, 1901-1902—Continued.

BARATARIA LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
1	Abadie	13,080.47	<i>Cents.</i> 14.60	\$1,896.67	<i>Feet.</i> 95	<i>Feet.</i> 175	<i>Feet.</i> 130	Washing.
2	Rodey extension	9,437.33	15.74	1,485.43	255	300	280	Making.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
1	St. Mary Chapel .....	.895	L.	James R. Marlow	<i>Feet.</i> 5,218	<i>Feet.</i> 5,600	<i>Feet.</i> 4.1

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.	
1	St. Mary Chapel	<i>Feet.</i> 8	3 to 1	3 to 1	Enlargement.	<i>Feet.</i> 3.6	<i>Feet.</i> 12.1	Mar. 12, 1902

No.	Name of levee.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition or contract.
				Least.	Greatest.	Average.		
1	St. Mary Chapel.....	55,219.00	<i>Cents.</i> 11	<i>Feet.</i> 112	<i>Feet.</i> 212	<i>Feet.</i> 176	Stationary.	Nothing done.

Summary of levees built from May 1, 1901, to May 1, 1902.

	District.				Total.
	Lower Tensas.	Atchafalaya.	Lafourche.	Barataria.	
Earthwork	159,108.92	45,983.11	104,118.74	22,517.80	331,678.57
Embankment.....	16,468	4,409	13,091	3,473	37,441
Axis of river covered	11,600	1,600	13,866	3,703	30,766

150 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Statement of yardage of levee work constructed by the United States and others in the Fourth district, Mississippi River.

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Barataria.	Pontchartrain.	Lake Borgne.
Aggregate number of cubic yards in levees on the Mississippi River May 1, 1901	16,653,503	18,400,912	7,612,006	2,823,222	13,661,060	3,198,035
Added by the United States up to May 1, 1902	159,109	45,933	104,119	22,518		
Added up to May 1, 1902, by the State and by the district levee boards	483,786	442,098	326,121	71,704	39,757	130,416
Total.	17,296,398	18,888,943	8,042,246	2,917,444	13,900,807	3,328,451
Lost by abandonment from May 1, 1901, to May 1, 1902:						
By the United States			6,400	8,800		
By the State and others	87,700		207,810	32,560		46,918
Aggregate remaining May 1, 1902	17,208,698	18,888,943	7,828,036	2,876,084	13,900,807	3,281,533

Percentage of length of existing levee system built in whole or in part by the United States.

Name of district.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Lower Tensas	47	52	52	59	63	66	72	71	71	72
Atchafalaya	8	16.8	43	47	68	65	67	68	69	68
Lafourche	6.5	14.4	28.8	54	61	61	62	75	82	83
Barataria	5.5	12.8	19.4	30	43	50	54	63	55	55
Pontchartrain	18	34.6	43.3	63	74	75	77	80	78	78
Lake Borgne	38	10.2	18	53	60	65	66	44.5	46	46

NOTE.—In the Lake Borgne district the percentage has decreased on account of the limit of the district having been extended from the lower line of Bohemia plantation to the upper line of the United States reservation at Fort St. Philip, an increase in the length of the levee line of 124,890 linear feet.

Percentage of total length of existing levee system, Fourth district, Mississippi River improvement, built in whole or in part by the United States.

Year.	Percent- age.	Year.	Percent- age.
	<i>Per cent.</i>		<i>Per cent.</i>
1893	13.8	1898	65
1894	26.2	1899	66
1895	36.6	1900	67.2
1896	62	1901	68.7
1897	63	1902	69

LOWER TENSAS LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$27,512.28, distributed as follows:

Office expenses, main office	\$1,049.79
Other administrative expenses	3,631.08
Construction of levees (contracts)	21,842.35
Repairs to levees	56.88
Surveys	893.36
Repairs to plant	29.00
Care of plant	4.00
New plant	6.32
Total	27,512.28

Money statement.

July 1, 1901, balance unexpended	\$40,558.43
June 30, 1902, amount expended during fiscal year	27,512.28
July 1, 1902, balance unexpended	13,046.15
July 1, 1902, outstanding liabilities	74.26
July 1, 1902, balance available	12,971.89

ATCHAFALAYA LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$1,924.26, distributed as follows:

Office expenses, main office	\$704.08
Other administrative expenses	969.40
Repairs to levees	204.98
New plant	45.80
Total	1,924.26

Money statement.

July 1, 1901, balance unexpended	\$26,015.10
June 30, 1902, amount expended during fiscal year	1,924.26
July 1, 1902, balance unexpended	24,090.84
July 1, 1902, outstanding liabilities	\$143.73
July 1, 1902, amount covered by uncompleted contracts	9,578.26
July 1, 1902, balance available	14,368.85

LAFOURCHE LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$11,967.40, distributed as follows:

Office expenses, main office	\$574.28
Other administrative expenses	1,578.92
Construction of levees (contracts)	9,543.37
Surveys	270.83
Total	11,967.40

Money statement.

July 1, 1901, balance unexpended	\$19,503.77
June 30, 1902, amount expended during fiscal year	11,967.40
July 1, 1902, balance unexpended	7,536.37
July 1, 1902, outstanding liabilities	53.04
July 1, 1902, balance available	7,483.33

BARATARIA LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$4,074.05, distributed as follows:

Office expenses, main office	\$200.00
Other administrative expenses	557.50
Construction of levees (contracts)	3,141.10
Surveys	175.45
Total	4,074.05

^a Balance unexpended July 1, 1901, as stated in previous report, \$40,555.33; difference due to disallowance of \$3.10 in expenditures.

152 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1901, balance unexpended	\$7,154.16
June 30, 1902, amount expended during fiscal year	4,074.05
July 1, 1902, balance unexpended	3,080.11
July 1, 1902, outstanding liabilities	959.95
July 1, 1902, balance available	2,120.16

PONTCHARTRAIN LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$2,937.22, distributed as follows:

Office expenses, main office	\$1,064.01
Other administrative expenses	1,177.96
Repairs to levees	287.12
Surveys	406.13
New plant	2.00
Total	2,937.22

Money statement.

July 1, 1901, balance unexpended	\$20,093.32
June 30, 1902, amount expended during fiscal year	2,937.22
July 1, 1902, balance unexpended	17,156.10
July 1, 1902, outstanding liabilities	\$114.73
July 1, 1902, amount covered by uncompleted contracts	14,110.19
July 1, 1902, balance available	2,931.18

LAKE BORGNE LEVEE DISTRICT.

The amount expended from June 30, 1901, to June 30, 1902, is \$1,497.42, distributed as follows:

Office expenses, main office	\$177.33
Other administrative expenses	181.75
Construction of levees (contracts)	385.59
Repairs to levees	685.00
Surveys	67.75
Total	1,497.42

Money statement.

July 1, 1901, balance unexpended	\$4,979.53
June 30, 1902, amount expended during fiscal year	1,497.42
July 1, 1902, balance unexpended	3,482.11
July 1, 1902, outstanding liabilities	342.50
July 1, 1902, balance available	3,139.61

The following maps and appendixes accompany this report:

- Plate I, Giles Bend, revetment.
- Plate II, Giles Bend, bank line.
- Plate III, Atchafalaya River, sill dams.
- Plate IV, New Orleans Harbor, Carrollton Bend, revetment.
- Plate V, New Orleans Harbor, Gouldsboro Bend, revetment.
- Plate VI, New Orleans Harbor, Algiers Point, revetment.
- Plate VII, Lower Tensas and Homochitto levee districts.
- Plate VIII, Atchafalaya, Lafourche, and Pontchartrain levee districts.
- Plate IX, Barataria and Lake Borgne levee districts.
- Appendix A, Commercial statistics.

Appendix B, Report of H. S. Douglas, assistant engineer, on revetment work.
 Appendix C, Report of L. E. Lion, junior engineer, on dredging at mouth of Red River.

Appendix D, Report of W. E. Knobloch, superintendent, on levees.

Very respectfully, your obedient servant,

G. McC. DERBY,
Major, Corps of Engineers.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

APPENDIX 4 A.

FOREIGN COMMERCE, PORT OF NEW ORLEANS.

The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. A. T. Wimberly, collector of customs:

Vessels.	Entrances.			Clearances.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
Steam.....	1,418	1,478	1,407	1,401	1,487	1,399
Sail.....	121	110	92	108	89	79
Total.....	1,539	1,588	1,499	1,509	1,576	1,478

Total tonnage of above.

1889-1900.....	4,467,308
1900-1901.....	5,248,725
1901-1902.....	5,360,560

Exports and imports.

	1900.	1901.	1902.
Exports:			
Total value of exports of foreign merchandise to foreign countries.....	\$1,189,157.00	\$1,719,880.00	\$2,661,271.00
Total value of exports of domestic merchandise to foreign countries.....	111,486,365.00	148,077,942.00	132,793,311.00
Total value of exports of domestic merchandise to Porto Rico.....		882,711.00	1,919,998.00
Domestic specie exported to foreign countries.....		3,000.00	8,500.00
Total.....	112,675,522.00	150,683,533.00	137,382,890.00
Imports:			
Total value of imports from foreign countries—			
Free.....	5,761,328.00	8,241,514.00	12,809,295.00
Dutiable.....	12,050,466.00	10,609,988.00	10,154,859.00
Transit to Mexico.....	2,210,581.00	735,302.00	2,104,950.00
Transported to interior ports.....	1,383,161.00	648,471.00	1,893,747.00
Specie.....	655,816.00	557,455.00	793,743.00
Total.....	22,061,352.00	20,792,730.00	27,756,594.00
Total duties collected.....	6,878,271.76	5,888,205.01	5,709,313.36

154 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

APPENDIX 4 B.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., May 1, 1902.

SIR: I have the honor to submit the following report on the works under my local charge from May 1, 1901, to May 1, 1902:

BONDURANT REVETMENT.

At date of last report the following work had been done at this locality:

Sixteen hundred linear feet of bank had been protected with a continuous mattress 100 feet wide, and a concrete-in-situ upper bank pavement extending up to about a two-thirds stage of the river. The revetment contained 30,000 square feet of board mattress, and 120,000 square feet of the usual framed willow mattress, together with 75,098 square feet of upper bank pavement.

The work is in good condition, but the usual pocket or cave has taken place at the lower end, and the revetment should be extended farther downstream during the forthcoming low-water season. On account of lack of funds no work has been done during the year.

CONCRETE BALLAST.

Operations were carried on this year at Kempe Towhead or Island. Past experience indicated that the difficulties and expenses of breaking up and loading concrete blocks made on the gravel bar rendered this method impracticable. The results of experiments pointed in the direction of making the blocks of concrete on barges afloat, thus avoiding the expense of rehandling.

After due consideration the following method was decided upon:

The automatic proportioning mixer described in last report was roughly installed on an old barge, so that the discharge projected clear of the side, in order that the mixed concrete would fall directly into the molds placed on another barge alongside. The necessary platforms for handling the raw materials, sand, gravel, and cement, were built around the mixer. It will thus be seen that all that was necessary to complete the installation was to move the plant to the gravel bar and build the runs out ashore, so that the sand and gravel could be wheeled to the mixer. While the financial results are disappointing, I think it well to here call attention to one grand, overshadowing result of the methods adopted on the work at large and clearly shown by the general economy of this season's operations. This result was the ample supply of ballast, always ready afloat, without hindrance or delay, for the actual construction of bank revetment.

Itinerary.—The plant arrived at Kempe Towhead on the evening of July 24, 1901. The force was organized and the actual manufacture of concrete commenced July 30, continuing with no incident worthy of note until September 28. On this latter date, after manufacturing 4,931 tons of concrete, operations were suspended, all barges available being loaded. At this time the major portion of the plant was needed at New Orleans Harbor; hence the scarcity of barges. The force was temporarily transferred to other work at Kempe and Giles Bend revetments, and it was not until January 21, 1902, a period of one hundred and fifteen days, that the manufacture of concrete was resumed. Certain necessary expenses incident to the care of the barges loaded with concrete and other plant were incurred during this period and have been charged against the concrete, as they would have been against rock or any other ballast. From January 21 the manufacture of concrete continued until March 22, when the rising river overflowed all of the gravel bar and compelled a suspension of work for the season. The plant was moved to "lying-up quarters," in Giles Bend, and the force disbanded.

Details.—The details of the manufacture of concrete ballast are as follows:

The old barge having the mixer on was moored at a convenient place opposite the dry gravel bar and runs built out ashore for the wheelbarrows. The covered barge loaded with cement was placed immediately above, and another barge with miscellaneous supplies moored immediately below. These barges occupied a length of 372 feet and formed a face or floating wharf against which the barges being loaded with concrete were maneuvered. The molds for the concrete blocks were set up on an empty barge in two rows, one on either side. This barge was then placed under the mixer so that the concrete would be discharged directly into the molds on one side and at the downstream end of the barge. The manufacture of concrete was then commenced, the barge being dropped down with the current as the particular molds under the discharge of the mixer were filled and tamped. On completion of one

row of molds, the barge was swung around and the same process gone through with on the other row of molds. In practice, it was found that the weight of a complete row of concrete blocks on one side was so great as to give the barge a dangerous list, so that only one-half a row could be placed before swinging the barge around and loading the other side. When a complete layer of concrete blocks had been made on both sides of the barge it was moved away and the concrete allowed to harden for twelve hours, when, generally, the molds could be pulled out. In the meanwhile, of course, similar work was progressing on another barge. After the molds had been pulled from the first barge a floor of 1-inch boards was placed on top of the first layer of concrete blocks, the molds again set up, and the whole process repeated until a second layer of blocks had been made, superimposed on the first. Inch boards were again placed over the second layer and a third tier of blocks put on, completing the loading of the barge with about 357 tons of concrete. Other details of manufacture are indicated elsewhere in the analysis of cost per ton.

The sand and gravel used was what is termed "run of the bar"—that is, in the proportions found in situ on the bar, the only selection being to avoid deposits of mud or silt. In general, the intended proportions were 1 part of cement to 16 parts run-of-the-bar sand and gravel. The blocks or slabs of concrete made were 8 feet long, 18 inches deep, and 6 inches thick.

Cost.—It requires an unusually fair, impartial, and judicial turn of mind to give the true cost of work of this kind, which of necessity is interwoven with other items of bank revetment. If each superintendent in immediate charge of each branch of the work made an independent report of the cost of his particular job there would be a large sum unaccounted for. It is one of the functions of the assistant in general charge to properly and equitably distribute expenditures. Referring to the regular financial statements, which of necessity are impartial, I find the amount charged to the manufacture of concrete ballast to be \$15,306.19. To this should be added the sum of \$1,141.15 expended for the care of the plant and manufactured concrete during the one hundred and fifteen days when work was enforcedly suspended, and in my judgment incorrectly charged to "Care of plant," giving a total of \$16,447.34. The total number of tons of concrete made on barges during the season was 8,199.37, which, divided into the foregoing total expended, gives \$2 as the absolute total cost per ton of concrete ballast loaded on barges ready to be towed to the point where used. This is one extreme. On the other hand the absolute total field cost on a selected day was:

Supervision, subsistence, care of plant, services of <i>Ruby</i> , coal, oil, wheeling sand and gravel, and making concrete, per ton	\$0. 394
Value of cement used, per ton .....	. 818

Total cost per ton of manufactured concrete

1. 212

This is the other extreme. As between \$2 and \$1.21 there is a difference of \$0.79, which will, I think, serve as a partial explanation of the varying figures given by different individuals at different times. Without further comment I submit analytical figures of the past season's work, with explanatory remarks. The gross cost of \$2 per ton comprises, besides the actual manufacture of concrete, such items as installation, several shiftings of the entire plant caused by rise and fall of the river, loss of time due to scarcity of barges and molds, repairs to plant and care of same during suspension of work for one hundred and fifteen days, the cost of experimental work, and part of the first cost of the 1-inch boards used to separate the layers of concrete blocks on the barges, the average proportion of each item being:

Cement	\$0. 854
Installation .....	. 060
Supervision .....	. 040
Subsistence .....	. 180
Care of plant .....	. 100
Crew of <i>Ruby</i> .....	. 083
Crew of <i>Comstock</i> .....	. 004
Coal, oil, etc .....	. 003
Operating mixer .....	. 039
Feeding sand and gravel to mixer .....	. 044
Feeding cement to mixer and shifting barge .....	. 028
Feeding water to mixer .....	. 014
Wheeling sand and gravel from bar to mixer .....	. 190
Distributing concrete in molds .....	. 035
Tamping concrete in molds .....	. 040
Moving and setting up molds .....	. 065

156 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Moving plant on account of rise and fall in river.....	\$0.025
Approximate wear and tear of lumber between layers.....	.027
Repairing plant .....	.033
Care of plant during one hundred and fifteen days when work was suspended. ....	.138

Total average cost per ton..... 2.002

From experience gained during the past season it is known that several of these items can be reduced or entirely eliminated. It is also known that a large saving in the actual manufacture can be made by doubling the number of mold plates used to separate the blocks. Those at present in use are of steel and are quite expensive, costing \$5 per pair. It was not contemplated to manufacture a large amount of concrete this season, and it is certain that some less expensive kind of mold plates can be found. For these reasons more plates were not purchased. Those on hand are only sufficient to contain about 140 tons of manufactured concrete, and as the plates must remain between the blocks for at least twelve hours they can only be used one time in one day. The mixer used is claimed to have a capacity of 300 tons per day, and for the reason given it was only run at about one-third its capacity. As many of the fixed expenses would be the same, whether the product was 100 or 300 tons per day, the possible improvement in this direction is obvious. Scarcity of barges also hampered the work, two and one-half days being entirely lost from this cause, and on numerous occasions the work was limited for the same reason.

As the foregoing table, giving a gross or total cost of \$2 per ton, contains many items on which there may be differences of opinion, the following table, giving what may be termed the net average cost per ton for concrete blocks on barges, is given:

Cement.....	\$0.854
Supervision .....	.040
Subsistence .....	.180
Crew of <i>Ruby</i> .....	.083
Coal, oil, etc .....	.003
Operating mixer.....	.039
Feeding sand and gravel to mixer .....	.044
Feeding cement to mixer and shifting barge.....	.028
Feeding water to mixer .....	.014
Wheeling sand and gravel from bar to mixer.....	.190
Distributing concrete in molds .....	.033
Tamping concrete in molds.....	.040
Moving and setting up molds .....	.065

Net average cost per ton..... 1.613

It was my intention to discuss in detail the cost of manufacturing concrete ballast in past years as compared with this, but after careful study I can find no certain common ground for comparative purposes. For instance, I find in last year's report a table giving the cost of making concrete blocks on barges in a manner almost precisely similar to that used this year. Omitting the last three items of that table, which do not relate to the manufacture of concrete at the gravel bar, I find the stated cost per ton to be \$1.575 for concrete blocks on barges. This cost, according to the text of the report, appears to be based on an estimate that three tiers of concrete blocks on a barge weigh about 450 tons. As a matter of fact they weigh only 357 tons. Correcting the cost to a basis of 357 tons to the barge, I find the figures to be \$2.243 per ton instead of \$1.575. For reasons of this kind, together with the omission of certain items of analytical detail and difference in the cost of labor, I consider that no very valuable data would be furnished by endeavoring to make comparisons, and will let the work of this season stand by itself. It is, however, fair to note that during the past season there has been an increase of 20 per cent in the cost of ordinary labor, and that provisions have increased in price, making subsistence more expensive. As ordinary labor and subsistence constitute about one-third the net cost of manufacturing concrete blocks, the increase in the value of these two articles naturally affects the cost of the work to a considerable extent.

SUMMARY.

Total amount expended for concrete ballast	\$16,447.34
Total tons (2,000 pounds) concrete ballast made.....	8,199.37
Gross cost per ton	2.00
Average net cost per ton for actual manufacture	1.618

Conclusion.—While the work of the past season puts beyond question the practicability of manufacturing concrete ballast at a cost that is advantageous, it is nevertheless a fact that it was somewhat in the nature of an experiment. The value of the experience gained has been far in excess of the reasonable amount expended, and it seems reasonably certain that with improvements now contemplated the gross cost of concrete ballast on barges in large quantities may be reduced 20 per cent, possibly more.

Mr. G. D. Waddill, jr., junior engineer, has been in immediate charge of this work and has shown unusual executive ability.

KEMPE BEND REVETMENT.

At date of last report the bank had been matted over a distance of 4,318 feet, and graded and paved for a length of 3,840 feet. The work was in good condition and promised that the results desired would be obtained. The revetment has been inspected from time to time during the year, and with the exception of a few small breaks in the upper bank pavement, and some caving at the extreme lower end, has remained in good condition. The caving of the bank forming a pocket or bay at the lower extremity is characteristic of all incomplete revetments, and in anticipation of this the upper bank was not paved for some distance above the termination of the subaqueous mattress.

The funds available for this work were limited, and have been held for some emergency that might threaten the destruction of the revetment at some point where the Kempe levee would be immediately threatened. Fortunately such emergency has not occurred, and operations have been confined to minor repairs to the upper bank pavement, felling timber along the banks that might cave in and obstruct the future extension of the revetment, to the accumulation of material, such as concrete ballast, to be in readiness for emergency work, and to a careful hydrographic survey over the revetment and vicinity.

The total disbursements for this work from May 1, 1901, to May 1, 1902, amount to \$17,660.43, distributed as follows:

Repairs to revetment, timber felling, etc	\$2,915.97
Manufacture of concrete ballast.....	4,849.00
Surveys	607.99
Miscellaneous.....	137.52
Repairs to plant.....	1,711.97
Care of plant.....	5,060.65
New plant	536.03
Contingencies and administration	1,841.30

Total 17,660.43

Material for construction to the value of \$7,673.64 is now on hand for use when work on the revetment is resumed. The hydrographic survey showed none of the violent changes in depth that occurred last year, and the indications were generally favorable to the success of the revetment. On February 26, when the work was last inspected, before being covered by the rising river, it appeared to be in good condition.

IMPROVING HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA (GILES BEND REVETMENT).

At date of last report a combination revetment of spur dikes and continuous mattress work, covering 7,060 lineal feet of bank in Upper Giles Bend, had been placed. The upper bank from Spur Dike No. 3 to No. 12 had been graded and paved to a line averaging about ten feet above low water, except at the spurs where the pavement had been carried up higher. In Lower Giles Bend 4,125 lineal feet of bank had been matted, and 3,275 lineal feet graded and paved. This work was all in good condition, no failure of any kind having occurred. A careful hydrographic survey made in November, December, and January, developed no unfavorable or alarming features.

The work projected this season consisted of the following: To prolong the Lower Giles Bend revetment about 1,000 feet upstream; to partially close a gap in last season's work which had been left unprotected to allow a salient point to cave back to the general line of the revetment; to mattress the bank in the "bight" of a deep pocket or bay about 2,000 feet above existing work, with the expectation that the projecting bank on either side would cave back until the shore line would be comparatively smooth for future work; to re-dress the grade and pave 850 lineal feet of upper bank, matted but not paved last year; to make a connection between the

upper bank pavement and the rock revetment on the upper end of Cowpen Neck levee, so that a channel would not scour out during extreme floods; and to repair spur dikes Nos. 9, 10, and 11 in Upper Giles Bend. All of this work has been done.

Itinerary.—Operations were commenced November 2, 1901, when the small quarter boat *Alpha* was moved to Lower Giles Bend, and the work of re-dressing and paving the 850 linear feet of upper bank begun. Incidental to this, a hydrographic survey over the work already in place, and for 1,000 feet above, was made. The force on the *Alpha* also cleared 1,150 feet of upper bank of logs, brush, etc., in readiness for hydraulic grading. On December 6, 1901, Grader No. 5 arrived on the ground and commenced grading for the extension of the revetment. Mattress construction was commenced December 30 at Quitman Bar, a few miles above Natchez. The quarter boat *Gamma* arrived at Quitman Bar December 11, and the work of building ways and cutting willow brush commenced. A sudden rise of the river overflowed the ways, and it was not until December 30 that mattress construction actually commenced. Meanwhile, on December 22, the quarter boat *Delta* and other plant arrived on the work, and the force on both boats was engaged on mattress construction until January 13, when the *Gamma* was moved to Lower Giles Bend and the sinking of mattresses commenced.

The *Delta* remained at Quitman Bar and continued mattress construction until March 7, when this branch of the work was suspended on account of high water. The quarter boat was then moved to Upper Giles Bend, and the force on her did the repair work at spurs 9, 10, and 11. On completion of this work, the force on the *Delta* was disbanded and the boat put out of commission. The *Gamma*, with her force, continued sinking mattresses and paving upper bank in Lower Giles Bend until March 15, when all work projected was completed and the plant laid up at the revetment.

Mattress construction.—This work was prosecuted under unusual difficulties at Quitman Bar. On December 11, when the *Gamma* arrived, the Vicksburg gauge read minus 1.4 feet. By December 31 it had risen to 21.6, falling to 6.6 on January 29. By February 13 it had risen to 31.2, again declining to 13.0 on March 3. During February the total change in the river surface amounted to 40.1 feet in twenty-eight days. To this was added very unfavorable weather, which caused a practical suspension of work for days at a time. During such periods the force of day laborers dispersed and it took some time to get them back. Rapid changes in the river, unfavorable weather, and a fluctuating and generally inadequate supply of labor made the work at this locality slow and expensive. To offset these unfavorable conditions was the fact that the principal employees were all trained men. But for this the cost would have been extravagant. As a matter of fact, it is only high as compared with other similar work done by the same force at other localities. A total of 499,435 square feet of mattress was built, using about 5,000 cords of willow brush cut from 141 acres of land. The following are the details of materials and cost:

Willow brush:	
Teams hauling	\$1,421.88
Cutting, loading, etc	2,600.57
Privilege of land	141.00
Total	4,163.45

Total cords of willow brush, 5,000. Cost per cord, delivered at ways, \$0.803.

<i>Construction—</i>	
10,000 feet B. M. miscellaneous lumber	\$110.00
168,390 feet B. M. 2 by 4 inch lumber	1,851.40
94,915 feet B. M. 3 by 6 inch lumber	1,044.06
7,990 pounds 9-inch steel wire nails	193.35
17,480 pounds 6-inch steel wire nails	416.08
2,197 pounds 4-inch steel wire nails	53.16
2,647 pounds No. 10 galvanized wire	79.41
5,000 cords willow brush	4,163.45
Treenails	50.00
Steamers and tugs	1,540.00
Miscellaneous	150.00
Provisions	2,152.53
Pay rolls	6,608.81
Total	18,412.25

Total square feet of mattress built, 499,435. Cost per square foot, \$0.0368.

Towing.—The place at which the mattresses were built was such a short distance above where they were to be sunk that the cost of towing is too small to be considered as a separate item. It has therefore been divided between the cost of mattress construction and sinking.

Sinking.—Nothing unusual occurred and this portion of the work was prosecuted from its commencement, January 17, to completion, March 12, in a routine way. The cost was affected to some extent by the same causes that hindered mattress construction, i. e., changing stage of the river and unfavorable weather. It should also be noted that instead of putting only 12 pounds of ballast on each square foot of mattress, the amount was increased to 14.58 pounds, adding \$1,337.44 to the cost of the work for this item alone. Concrete ballast manufactured at Kempe Towhead was used exclusively. A total of 499,435 square feet of mattress was successfully placed, and the usual detail of cost is given:

Steamers and tugs	\$1, 550. 00
Lumber, wire, wire nails, etc	264. 65
3,640 tons concrete ballast	7, 571. 20
Miscellaneous	65. 78
Provisions	758. 50
Pay rolls	2, 351. 99
Total	12, 562. 12

Cost, per square foot, to sink, \$0.02516.

Cost of mattresses in place:

Construction per square foot	\$0. 03680
Sinking .....	. 02516

Total cost per square foot in place

. 06196

Grading upper bank.—Hydraulic grader No. 5 was operated exclusively; but one jet was used, the crew working eight hours. I do not consider the work of this season as a fair test of what this machine can do, as it has so far been operated to only one-half its capacity. By using two jets, which would only entail the addition of four men to the crew, the amount of work done can almost be doubled. However, the bank graded this year was unusually full of stumps and roots and comprised alternating strata of sand, clay, silt, and ooze. This, with the fact that the rapid changes in the stage of the river necessitated going over considerable of the grade a second time, would have caused the work to be expensive under any circumstances.

Total cost of hydraulic grading, including services of tug and incidentals. \$2, 958. 12	
Lineal feet of bank graded	1, 700
Cost per lineal foot of graded bank	\$1. 74

Paving upper bank.—Nothing but the concrete-in-situ pavement described in previous reports was used. Some changes in the details were made, the embedded wire mesh being omitted entirely, and over a considerable area the strips of 2 by 4 inch lumber, dividing the concrete into squares 5 feet on a side, were not put in. In lieu of this the pavement was laid in alternating squares. For illustration, squares 1, 3, 5, 7, etc., were laid in the forenoon and squares 2, 4, 6, 8, etc., in the afternoon. On this, as on other branches of the work in Giles Bend, the cost was increased by the rapid and constant changes in the river surface and unfavorable weather. The rapid rise of the river overflowed several thousand square feet of pavement before it had set sufficiently, and by an unfortunate coincidence the rise was accompanied by high winds, causing waves, which washed the soft concrete to pieces. For this reason many thousand square feet of pavement had practically to be laid twice, the second work being done when the river fell. As credit can only be taken for that which appears on the ground the cost per square foot is high. The proportions used were generally 1 part cement to 16 run-of-the-bar sand and gravel. By an error a considerable area was paved with pure sand and cement in these proportions, and, astonishing as it may seem, it was holding against wave wash up to the time that the rising river covered it. Toward the end of the work, on account of the large amount of sand contained in the material obtained at Kempe Towhead, the proportion of cement was increased to 1 part to 13 of sand and gravel. The cost of sand and gravel delivered at Giles Bend was excessive and unreasonable. Considering the foregoing, it is not surprising that paving was more expensive than heretofore. However, nothing has occurred during the past season to change my opinion that this is the best and cheapest upper bank pavement that has yet been invented.

160 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Cost of paving in detail is:

846 barrels of cement, at \$2.82.....	\$2,385.72
25,000 feet B. M. 2 by 4 inch lumber, at \$11.....	275.00
800 pounds 4-inch steel wire nails, at \$2.40.....	19.20
2,064 tons sand and gravel, at \$0.46.....	949.44
Tug <i>Tilda</i> 22 days, at \$20.....	440.00
Miscellaneous.....	45.00
Provisions.....	674.99
Pay rolls.....	1,839.27
Total.....	6,628.62

Total square feet bank paved, 109,550; cost per square foot, \$0.06051.

In addition to this the sum of \$222.78 was expended in removing partially wrecked pavement at the upper end of last season's work, and in minor repairs, making a total of \$6,851.40.

Timber felling.—There was but little actual timber felling done, but the bank had to be cleared of logs, brush, etc., for the hydraulic grader. About 1,150 lineal feet of bank was cleared at a cost of \$304.17, divided as follows:

Launch <i>Ruby</i>	\$26.64
Provisions.....	70.00
Pay rolls.....	207.53
Total.....	304.17

Acres cleared, about 5½; cost per acre, \$55.30.

Installation.—In the itinerary of operations will be found the details of the movements of the plant which constitute installation. Cost, \$438.37.

Surveys.—A complete hydrographic survey over the work in place in Giles Bend and for about 1,000 feet above the lower revetment was made in November, December, and January. The hydrography of this survey covered 119.4 acres. In February a survey was made over the mattress work placed this season covering about 11 acres. The caving of the bank in the unprotected interval between the upper and lower revetments destroyed a portion of the main base or traverse line around the bend and it had to be replaced. As the bank line is located by ordinates, measured out at intervals of 100 feet from the main base, these ordinates had to be relocated, cleared out, and measured. The aggregate of this sort of surveying was 7.6 miles of accurate work, all through heavy timber, dense underbrush, fallen trees, and drift. All construction was carefully located instrumentally. The desired position of each mattress was first ranged out and its actual position on the bottom determined afterwards by locating wires fastened to the mattress, and hauled taut and plumbed after sinking. The position of paving and upper bank work was determined, and all the data necessary to the platting and keeping up of an accurate field or progress chart obtained. The total cost of the survey work was \$1,260.65.

Cost.—The total disbursements for this work from May 1, 1901, to May 1, 1902, amount to \$52,227.61, distributed as follows:

Construction of mattresses.....	\$18,412.25
Sinking of mattresses.....	12,562.12
Grading upper bank.....	2,958.12
Paving upper bank.....	6,851.40
Clearing upper bank for grading.....	304.17
Installation.....	438.37
Surveys.....	1,260.65
Miscellaneous.....	92.34
Repairs to plant.....	3,455.32
Care of plant.....	116.26
New plant.....	153.81
Contingencies and administration.....	5,622.80
Total gross cost.....	52,227.61
Deduct last four items.....	9,348.19
Total net cost.....	42,879.42

Summary.—The total amount of construction done in Giles Bend this season consists of:

Linear feet of bank protected, Lower Giles Bend	1,500
Linear feet of bank matted, Lower Giles Bend	1,500
Linear feet of bank graded, Lower Giles Bend	1,700
Linear feet of bank paved, Lower Giles Bend	2,000
Square feet of mattresses sunk at spurs in Upper Giles Bend	22,505

Conclusion.—As stated, the gross cost of the work from May 1, 1901, to May 1, 1902, is \$52,227.61. The unit of cost desired is the linear foot of protected bank, and in order to obtain this it is necessary to first deduct the cost of the repair work in Upper Giles Bend, including its pro rata of the contingent expenses. Therefore:

Total amount expended	\$52,227.61
Less cost repair work, Upper Giles Bend	1,162.44
Gross cost work in Lower Giles Bend	51,065.17
Gross cost per linear foot of protected bank	34.06
Total amount expended, less repairs to plant, care of plant, new plant, and contingencies and administration	42,879.42
Less cost repair work Upper Giles Bend	1,162.44
Net cost of work in Lower Giles Bend	41,716.98
Net cost per linear foot of protected bank	27.81

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

The adopted project for the further prosecution of this work contemplated widening the foundation mats above and below each sill dam, and the placing of the foundation mattress for a new sill dam immediately above existing No. 1.

As the funds were limited, operations during the past season have been confined to widening the foundation mats of the existing sills; that on No. 1 being increased to 560 feet, and on No. 3 to 430 feet.

Itinerary.—Operations were commenced July 27, 1901, when the quarterboat *Gamma* and necessary plant was towed to Angola Bar in the Mississippi River near the mouth of Red, and the building of ways and cutting of willow brush began. On August 7 the quarterboat *Delta* was moved to Angola. Mattress construction was commenced August 9 and prosecuted by the labor on both boats until September 1, when the *Gamma* was moved into the Atchafalaya near the sill dams. The *Delta* remained at Angola Bar and the force on her continued mattress construction for the Atchafalaya sills until September 17. Meanwhile the force on the *Gamma*, with the necessary plant, commenced the sinking of mattresses above and below the existing sill dams on September 4. This work was completed on September 26 and the plant moved away to another locality to build mattresses and cribs for New Orleans Harbor.

Mattress construction.—On this work, as on all others prosecuted this season, scarcity of and irregular supply of labor hindered rapid and economical construction. It is impossible to obtain any large number of white laborers for reasonable wages in this part of the country before October 1. Consequently negroes have to be depended on and this year even they were scarce, and as a necessary consequence very indifferent and independent. On September 4 all the negroes quit work and left the quarterboat because they had not been paid off for the previous month as promptly as they thought they should have been. It took some time to arrange matters and again accumulate a force. As a consequence, while the cost of mattress construction is not excessive, it is higher than it would have been with an ample, reliable supply of labor.

Willow brush.

* Teams hauling	\$870.87
Cutting, loading, etc.	2,166.04
Total	3,036.91

Total cords of willow brush, about 4,050. Cost per cord, delivered at ways, \$0.75.

Sup. Eng.—02—11

Mattress.

500 feet B. M. miscellaneous lumber	\$55. 00
133,789 feet B. M. 2 by 4 inch lumber	1, 471. 68
49,580 feet 3 by 6 inch lumber	655. 38
6,355 pounds 9-inch steel wire nails	153. 79
13,902 pounds 6-inch steel wire nails	330. 86
1,747 pounds 4-inch steel wire nails	41. 29
2,105 pounds No. 10 galvanized wire	63. 15
4,050 cords willow brush	3, 037. 51
Treenails	40. 00
Steamers and tugs	820. 00
Miscellaneous	100. 00
Provisions	1, 487. 41
Pay rolls	4, 711. 25

Total 12, 967. 32

Total square feet of mattress built, 397,200. Cost per square foot at ways 0.03264.

Towing.—After the mattresses were built they had to be towed through Old River and down the Atchafalaya to Simmsport, a distance of about 13 miles. The cost of towing is as follows:

Tug <i>Humphreys</i> , ten days, at \$27	\$270. 00
Tug <i>Comstock</i> , eight days, at \$20	160. 00

Total 430. 00

Total square feet of mattress towed 397,200. Cost per square foot for towing, \$0.001083.

Sinking.—The quarterboat *Gamma*, with a small force and the necessary plant, was moved to the Atchafalaya sill dams on September 1. The plant was put in position and an attempt made to sink a mattress on the lower edge of Sill Dam No. 3. Some errors of judgment were made in estimating the strength of the current and it drifted below the desired position while being sunk. It is therefore considered as lost, not being effective as designed to widen the foundation mattress of the sill. This was the only accident at this or any other locality during the season's work. A strip of mattress 150 feet wide was carried entirely across the Atchafalaya, lapping 20 feet over the lower edge of the original foundation mattress of Sill Dam No. 5. Two similar strips were sunk successfully, one on the upper and the other on the lower edge of the original foundation mattress of Sill Dam No. 1, with the same lap. A total of 397,200 square feet of mattress was sunk on the two sills, but of this 45,000 square feet drifted below the desired location and is considered lost. The effective mattress work is 352,200 square feet, and in computing the cost the value of the lost work has been included.

Cost in detail is—

Steamers and tugs	\$480. 00
Lumber, wire, wire nails, etc.	102. 20
2,581 tons concrete ballast	5, 574. 96
Miscellaneous	31. 00
Provisions	422. 33
Pay rolls	1, 719. 20

Total 8, 329. 69

Square feet of mattress successfully sunk, 352,200. Cost per square foot to sink, \$0.02365.

Cost of mattress in place.

Construction, per square foot	\$0. 032650
Towing, per square foot .....	. 001083
Sinking, per square foot .....	. 023650

Total cost per square foot in place057383

Installation.—The cost of moving plant to the work and installing same was \$114. 21.

Additional ballast.—On this work, as on that at other localities this year, the amount of ballast per square foot of mattress was increased about 20 per cent. On further study of the conditions existing at Sill Dam No. 1 you decided that additional ballast was necessary on the new mattress work on the upper side of the dam.

Accordingly, on March 20 and 21, 1902, 375 tons additional ballast was distributed over it, making a total of about 21 pounds to the square foot. As a special trip of a tug, barge, and small force from Giles Bend to Simmsport and return was necessary, this work cost \$909.07, including value of ballast.

Cost.—This report does not include the maintenance of a channel through Old River, and the cost of this work is not given here. The total amount expended on the sill dams from May 1, 1901, to May 1, 1902, is \$29,258.51, distributed as follows:

Construction of mattress	\$12,967.32
Towing of mattress	430.00
Sinking of mattress	8,329.69
Installation	114.21
Additional ballast	909.07
Repairs to plant	1,585.66
Care of plant	592.02
New plant	501.93
Miscellaneous	19.83
Contingencies and administration	3,808.78
Gross cost of work on sill dams	29,258.51
Deduct last five items	6,508.22
Net cost of work on sill dams	22,750.29

Summary.—No upper-bank work being required, operations on the sill dams consisted of the successful placing of 352,200 square feet of mattress.

Conclusion.—The only available unit of cost in this case is the square foot of mattress successfully placed. The total expenditures, including such items as "Repairs to plant," "New plant," "Care of plant," and "Contingencies and administration," are \$29,258.51, making the cost of mattress in place \$0.08307.

I hope that it is unnecessary for me to say that this last figure is without value for comparative purposes. The figures \$0.057383, given under the heading "Cost of mattress in place," are the ones to be used when comparing the work of this season with that of past years. Such previous work has not been put to the test by which I arrive at the figures \$0.08307.

NEW ORLEANS HARBOR.

The work projected this season consisted of placing six spur dikes, to close the gap between the Gouldsboro and Algiers Point systems, and the mattressing of the lower half of the slope of the bank for a distance of 1,800 feet above and 1,800 feet below the existing work in the Carrollton Bend (Southport). The six spurs and the lower 1,800 feet of the Carrollton Bend work have been done. The upper 1,800 feet has not been mattressed this season for reasons given further on in this report.

Itinerary.—Operations were commenced September 18, at Angola Bar, when, after completing the necessary mattress work for the Atchafalaya sills, the force on the *Delta* began building for New Orleans Harbor. By October 2 the willows on Angola Bar were all used, and the *Delta* with her force was transferred to Lumms Bar, about 4 miles farther up the river. Previously, on September 27, the quarterboat *Gamma*, after completing the sinking of mattresses on the Atchafalaya sill dams, had been towed to Lumms Bar and commenced work on cribs and mattresses for New Orleans Harbor. The supply of white labor on the *Gamma* was very scant. At one time the force dwindled down to only twenty laborers, and the idea of putting the boat out of commission was entertained. There was nothing to be gained by changing the labor from white to colored, because there were more than sufficient accommodations on the *Delta* for all of the latter that could be obtained. Such labor as we had was far from efficient, being sulky and unwilling. Matters culminated on November 11, when all the laborers, white and black, struck for what was virtually an increase of 20 per cent in wages. From November 11 to 16 work was practically suspended. On the latter date, concessions having been made, some of the laborers returned to work. It, however, took some time to again build up the force. As a consequence of these troubles the work was delayed and its cost increased. It was not until December 20 that the mattresses and cribs for the Gouldsboro-Algiers dikes and sufficient mattresses for the lower 1,800 feet of the Carrollton Bend work were completed. On that date the willow brush on Lumms Bar was exhausted, so that under any circumstances it was necessary to move the mattress-constructing plant to some other locality. It was known that a further extension upstream of the Lower Giles Bend revetment before high water was essential to

the preservation of the good results already obtained at that locality. It was also evident that the possible working season was far advanced. After due consideration it was decided to move the mattress-constructing plant to a willow bar above Giles Bend and build mattresses for that work. It was hoped that the river would remain low and that the working season would be so prolonged that after the completion of the Giles Bend work sufficient mattresses for the upper 1,800 feet in the Carrollton Bend could be built. Unfortunately this could not be done. Meanwhile, on October 4, the first tow of mattresses and cribs for the Gouldsboro-Algiers spurs left Lumms Bar and arrived in New Orleans on October 11. The quarter boat *New Orleans* moored at the engineer depot, was put in commission, and the plant placed in position to sink Spur No. 7 on October 18. By November 23 Spurs 7, 8, 9, 10, and 11 and $4\frac{1}{2}$ having been successfully completed the plant was moved to Carrollton Bend (Southport) and the first mattress for that work successfully sunk on December 6. The downstream 1,800 feet of this work was completed on January 1, 1902, and the quarter boat *New Orleans* put out of commission and with other plant returned to the engineer depot at New Orleans.

The general work of sinking was considerably delayed and its cost slightly increased by the slow delivery of cribs and mattresses. The reason for this was the absence of current in the river below Baton Rouge, which made the towing very slow. A double crew was put on the boat, but even then it required from five to eight days to bring a tow from Lumms Bar to New Orleans, a distance of about 206 miles.

Crib and mattress construction.—The work of building mattresses and cribs for the Gouldsboro-Algiers spurs, and of building mattresses alone for the work in Carrollton Bend, is of necessity so interwoven that it is not practicable to separate them. The difficulties and incidents attending this portion of the work have already been given in the itinerary. In all 460,800 cubic feet of cribs, and 810,000 square feet of mattress were built, the details of materials and cost being:

Willow brush.

Teams hauling	\$2, 774. 76
Cutting, loading, etc.	4, 615. 95
Privilege of land	251. 00
Total	7, 641. 71

Total cords of willow brush, about 10,750. Cost per cord delivered at ways, \$0.71.

Cribs.

300 feet B. M. miscellaneous lumber	\$33. 00
53,913 feet B. M. 3 by 6 inch lumber	593. 04
5,990 pounds 9-inch steel wire nails	144. 95
1,769 pounds 6-inch steel wire nails	42. 76
829 pounds No. 10 galvanized wire	24. 87
2,500 cords willow brush	1, 775. 00
Treenails	12. 00
Steamers and tugs	600. 00
Miscellaneous	60. 00
Provisions	806. 28
Pay rolls	3, 430. 81
Total	7, 522. 71

Total cubic feet of cribs built, 460,800. Cost per cubic foot at ways, \$0.0163.

Mattress.

10,000 feet B. M. miscellaneous lumber	\$110. 00
272,970 feet B. M. 2 by 4 inch lumber	3, 002. 67
111,500 feet B. M. 3 by 6 inch lumber	1, 226. 50
12,960 pounds 9-inch steel wire nails	313. 63
28,350 pounds 6-inch steel wire nails	674. 73
3,564 pounds 4-inch steel wire nails	86. 24
4,293 pounds No. 10 galvanized wire	128. 79
8,250 cords willow brush	5, 866. 71
Treenails	83. 00
<i>Steamers and tugs</i>	1, 280. 00

Miscellaneous	\$140. 00
Provisions	3, 383. 93
Pay rolls	8, 163. 05
Total	24, 459. 25

Total square feet of mattress built, 810,000; cost per square foot at ways, \$0.030197.

While it was not practicable to keep the field cost of mattress construction separate for the Gouldsboro-Algiers spurs, and the lower bank continuous revetment in the Carrollton Bend, it has been possible to keep separate account of other items.

Therefore from this point on separate report is made on the work at the two localities in New Orleans Harbor.

GOULDSBORO-ALGIERA SPURS.

In 1885, 1886, 1887, and 1888 six spur dikes were placed in what has been termed the "Gouldsboro Bend." In 1889 six more spur dikes were placed at the Algiers Point and for some distance above. All these spurs were designated by numbers, commencing at the head of the Gouldsboro series with No. 1 and ending with No. 17 at the Algiers Point. Prior to the present season spurs Nos. 1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16, and 17 had been placed. The interval between spurs 4 and 5 (about 900 feet) was considered too great and an intermediate spur, designated as No. 4½, was decided on. This, with Nos. 7, 8, 9, 10, and 11, constituted this season's work, and completes the series for the present.

Detail of constructing cribs and mattresses has already been given.

Towing mattresses.—The distance from Lumms Bar, where the mattresses and cribs were built, to New Orleans is about 206 miles. All towing was done by our tug the *General A. A. Humphreys*, most of the time with a single crew, and the cost was:

Tug *Humphreys*, 36 days, at \$27..... \$972. 00

Square feet of mattress towed 206 miles, 360,000. Average cost per square foot for towing, \$0.00270.

Towing cribs.—These were towed under exactly the same conditions as the mattresses:

Tug *Humphreys*, 20 days, at \$27..... \$540. 00

Cubic feet of cribs towed 206 miles, 460,800. Average cost per cubic foot for towing, \$0.00117.

Sinking spur dikes.—All of the spurs were exactly alike, consisting of a foundation mattress 150 by 400 feet, and two cribs superimposed on each other, the bottom one 6 feet high, 24 feet wide, and 300 feet long, and the top one 6 feet high, 16 feet wide, and 350 feet long. For this reason the details of each spur, given in previous reports, are omitted.

No unusual incidents attended the sinking of the spurs from date of commencement, October 18, until completion, November 23. The only obstacle encountered was at spur 4½, which happened to be located at the transfer incline of the Texas and Pacific Railway. This obstacle was overcome by the obliging action of the railway company in building a temporary incline for use while the spur was being placed. Detailed cost of sinking is given below:

Mattress for spur dikes.

238 tons concrete ballast	\$518. 84
483.11 tons rock (ship's ballast), at \$1.10	531. 42
1,222.89 tons rock, at \$1.62½	1, 987. 20
415 tons run-of-the-kiln brick, at \$2.40	996. 00
Lumber, wire, wire nails, etc	110. 72
Steamers and tugs	500. 00
Miscellaneous	27. 87
Provisions	627. 56
Pay rolls	1, 987. 80
Total	7, 287. 41

Total square feet of mattress sunk, 360,000. Cost per square foot to sink, \$0.02024.

Cribs for spur dikes.

901 tons rock, at \$1.62½	\$1,464.12
504 tons run-of-the-kiln brick, at \$2.40	1,209.60
123.63 tons terra cotta, at \$1.20	148.36
177 tons brickbats, at \$1	177.00
Lumber, wire, wire nails, etc.	47.12
Steamers and tugs	260.00
Miscellaneous	20.00
Provisions	323.93
Pay rolls	1,039.97
Total	4,690.10
Total cubic feet of cribs sunk, 460,800. Cost per cubic foot to sink, \$0.01018.	

Cost of mattress in place.

Construction per square foot	\$0.030197
Towing per square foot .....	.002700
Sinking per square foot .....	.020240
Total cost per square foot in place .....	.053137

Cost of cribs in place.

Construction per cubic foot	\$0.01630
Towing per cubic foot .....	.00117
Sinking per cubic foot .....	.01018
Total cost per cubic foot in place .....	.02765

Installation.—This item is the cost of getting the plant on the ground and ready for work. For the Gouldsboro-Algiers spur dikes it amounted to \$367.13.

Summary.—A total of 360,000 square feet of mattress and 460,800 cubic feet of cribs were placed in six spur dikes.

Conclusion.—The total field cost of the six spur dikes placed this year in the Gouldsboro-Algiers system is \$32,247.77. They are designed to protect 2,675 linear feet of bank, and the estimated cost in the project was \$15 per linear foot. As the field cost amounts to only \$12.05, it will be seen that the work has been done for about 80 per cent of the estimate. This is the more gratifying because almost everything that enters into the work has increased in price—labor, provisions, material, etc.

CARROLLTON BEND (SOUTHPORT) REVETMENT.

The lower bank revetment placed here this season is unique and is probably the only work of the kind on the Mississippi River. It consists of a strip of mattress about 1,800 feet long and 250 feet wide, so placed that its inshore edge rests on about the 60-foot contour, and from thence extends out to deep water in the channel of the river. The reasons for this rather unusual work are that at this locality the sub-aqueous bank of the river stands on a very steep slope. From a depth of 60 feet out to deep water in the river the slope is reasonably flat, but from 60 feet up to the bank line at low water the slope is 1 on 1 or steeper.

On such a slope, where it is evident that the stability of the bank has already been destroyed, continuous mattress work of the usual type gives no promise of success. The project contemplated mattressing the lower half of the slope, leaving the bank above the 60-foot contour unprotected so that it may crumble or cave away gradually until a slope of about 1 on 3 is attained. Then the upper half will be mattressed and the revetment completed. The project also contemplated accelerating this result by dredging away the upper bank between the 0 and 30-foot contours. Some work in this direction has been done and is described in its proper place in this report.

As an engineering problem, the placing of mattresses so that their inshore edges would follow a bank line 60 feet and more below the water surface was a difficult one. How well the task has been accomplished is shown on the chart of the work where the mattresses are platted in their actual position on the bottom, from instrumental locations after they were sunk. Assistant Engineer E. B. Geddes was in immediate charge of the sinking, and is to be congratulated on the success of his methods.

Mattress construction.—All mattresses were built at Lumms Bar, near Fort Adams, and this branch of the work has been described in detail.

Towing.—The tugs *General A. A. Humphreys* and *General Comstock* were engaged on this work, the cost of which was:

Tug <i>Humphreys</i> , 30 days, at \$27	\$810
Tug <i>Comstock</i> , 10 days, at \$20	200
Total	1,010

Square feet of mattress towed 200 miles, 450,000. Average cost per square foot for towing, \$0.00224.

Sinking mattresses.—As has been described, this particular work required that the mattresses be kept fully under control while they were being lowered through not less than 60 feet of water. This was done successfully and without excessive cost, as will be seen from the following itemized statement:

520.58 tons rock, at \$1.62½	\$845.94
1,866.82 tons rock (ship's ballast), at \$1.35	2,520.21
299 tons run-of-the-kiln brick, at \$2.40	617.60
712 tons brickbats, at \$1	712.00
Lumber, wire, wire nails, etc	138.10
Steamers and tugs	822.00
Miscellaneous	57.40
Provisions	863.46
Pay rolls	2,589.25
Total	9,165.96

Total square feet of mattress sunk, 450,000. Cost per square foot to sink, \$0.02037.

Cost of mattresses in place.

Construction per square foot	\$0.03019
Towing per square foot .....	.00224
Sinking per square foot .....	.02037

Total cost per square foot in place

.05280

Dredging upper bank.—In order to accelerate the scouring away or cutting back of the unprotected bank above the 60-foot contour, it was decided to dredge away the material in the vicinity of low-water mark—say, from about the 30-foot contour—to the top of the natural bank. As no advantageous offers to do this work by contract could be obtained, the hydraulic dredge *The Ram* was tried. On account of the character of the material and the great number of imbedded stumps, requiring the use of dynamite for their removal, the cost of dredging was excessive, and after about one month's trial the attempt was abandoned. A total of about 5,984 cubic yards of material was moved at a field cost of \$1,014.96.

Installation.—The proportion of installation expenses chargeable to the work in the Carrollton Bend is \$469.37.

Cost.—The total disbursements for this work from May 1, 1901, to May 1, 1902, amount to \$76,847.05, distributed as follows:

Construction of cribs	\$7,522.71
Construction of mattresses	24,459.25
Towing mattresses and cribs	2,522.00
Sinking mattresses and cribs	21,143.47
Dredging upper bank	1,014.96
Installation	836.50
Surveys	339.99
Repairs to plant	6,029.74
Care of plant	4,507.15
New plant	1,751.36
Contingencies and administration	6,719.92

Gross total expended	76,847.05
Deduct last four items	19,008.17

Net cost of work

57,838.88

Summary.—The total amount of bank protection work done in New Orleans Harbor this year consists of 2,675 linear feet of bank protected by six spur dikes, and 1,800 linear feet of bank below the 60-foot contour protected by a continuous mattress. About 5,984 cubic yards of earth have been moved from the upper bank in the Carrollton Bend to grade the same.

Conclusion.—On account of the character of the work, it is impracticable at present to establish the unit of cost per linear foot of protected bank. The exact length of bank protected by spur dikes is somewhat indeterminate because it is not known but what additional spurs may have to be built between those now in place. Of course the 1,800 linear feet of continuous mattress placed this season in the Carrollton Bend, below the 60-foot contour, can not be considered complete work. In 1897 (see Report of the Chief of Engineers, p. 3805) I gave the absolute total amount appropriated and expended for all purposes during a period of fourteen years. I deducted from this total the value of plant and material on hand, and divided the remainder by the linear feet of bank protected. The quotient gave the gross cost of bank protection work in New Orleans Harbor to be \$37.70 per linear foot. In about five years from now another analysis may be made and the cost determined in the same manner. In the meanwhile, I think that calculations would be misleading.

On the basis per square foot of mattress and per cubic foot of cribs the cost of this season's work has been less than that of similar work executed in previous years.

PLANT.

At date of last report the plant consisted of 47 large pieces, generally in good condition. No large pieces have been acquired during the year, and none have been disposed of.

Repairs.—Repairs during the past year have been confined principally to the steam plant of the district, which, as the most vital portion, must, if the funds are available, be kept in good condition. Some urgent repairs were also made to barges and quarterboats. The details are here given:

Steamer General John Newton.—Docked; hull scraped, heated, and given two coats of coal tar to light water line; pilot house repaired; stern bulkhead from boiler deck up renewed; new stairway from boiler deck to hurricane roof; main deck repaired and calked; bulkhead around boilers repaired; six new swinging fenders made; entire new canvas roof put on hurricane deck; interior of hull scraped and painted; boiler breeching repaired; new end put on main shaft and crank fitted to same; entire new wheel built; new brass plungers for air pump made; new piston rods put in circulating pump; deck pumps fitted with new valves; water valve chambers of doctor bored out and new seats and valves fitted in place; balance throttle valve trued up and ground to a fit; low-pressure cam trued up and cam yokes planed; new cam-rod bracket made; new rudder blade put in; cabin and hull painted. Cost, \$2,126.81.

Tug General A. A. Humphreys.—Docked; hull scraped, heated, and painted with coal tar to light water line; stern bushing renewed and 36 new rivets put in keel; new steam capstan purchased and installed; boiler breeching enlarged; throttle and steam-reversing levers changed from starboard to port side of engine and fitted with arcs and spring latches; high-pressure cylinder rebored, piston banded and new follower and packing rings put in; high-pressure steam chest rebored and fitted with new spring packing; set of brass piston-rod packing rings fitted between high-pressure and low-pressure cylinders; low-pressure cylinder follower faced and new packing rings fitted to piston; valve stems for steam chests of both high-pressure and low-pressure cylinders renewed; low-pressure valve stem fitted with new brass guides; link trued up and link block fitted with new brass gibs; link pin dressed and fitted; new steel crosshead, steel nut, and keeper fitted to piston rod; slides planed and crosshead gibs on go-ahead side faced with copper; four horseshoe thrust rings filled with white brass and fitted to collars in shaft; new separator tank installed; new tiller put on rudder stock; condenser overhauled and tubes packed; water supply to boiler generally overhauled; new grate bars in furnaces; cabin repaired and new canvas roof put on; entire boat painted. Cost, \$1,970.95.

Tug General Comstock.—Docked; 2 graving pieces put in hull below water line; portions of iron sheathing renewed; deck repaired; 6 new coal bunker hatches with cast-iron covers put in and 4 new iron cavils; hull painted to light water line with two coats coal tar, applied hot; rudder repaired; roof repaired; cabin varnished; main valve on engine planed and seat faced; wear on valve stem in guides planed out; link and link block refitted and pin bushed; 5 set screws for spring packing renewed; 5 brass and 3 cast-iron thrust rings renewed; new cast-iron bushing put in stern bearing; again docked on account of loose wheel; new key

made and propeller again fitted on shaft; loose rivets in rudder renewed and hull painted with coal tar to light water line. Cost, \$572.94.

Tug Tilda.—Docked; 6 pieces planking, 8 graving pieces, 8 frames, and samson post renewed; hull calked and painted with coal tar to light water line; new cast-iron bushing in stern bearing; main valve planed and seat faced; lost motion in valve yoke taken up; steel key made and fitted in crosshead; lost motion in reversing gear taken up; steam valve of boiler feed pumps faced; 4 brass thrust rings renewed; new sheet in boiler over furnace and 4 new boiler tubes; entire new furnace. Cost, \$394.99.

Dredge The Ram.—Docked; hull scraped, heated, and painted with coal tar to light water line; interior of hull scraped and painted; inside woodwork of new cabin finished and cabin painted throughout; worn parts of main centrifugal pump renewed; 18 feet of suction pipe repaired; exhaust pipes of propelling engines repaired; 2 entirely new smokestacks put up. Cost, \$1,306.37.

Launch Ruby.—Docked; new stern, 12 plank on each side of bow, 1 plank in cutting strake, 13 rake plank, 90 linear feet of upper and 100 linear feet of lower plank shear, and 26 outriggers put in; 25 outriggers repaired; 3 deck beams, 7 floor timbers, 20 frames, 2 clamps, 85 linear feet of nosing, deck on bow, and 2 wooden cavils renewed; 2 iron cavils put on bow; 1 new rudder and the other repaired; 4 rudder bumpers fitted to transoms; roof repaired; roof and cabin painted; 2 coats coal tar on hull to light water line; 2 new crank pins and brasses; 3 steel gibs and 1 key; links of both engines trued up and 2 new brass blocks made and fitted to same. Cost, \$676.80.

Quarterboat New Orleans.—Docked; new stern and apron with necessary planking put in after end; stern band repaired and refastened; 60 top timbers and 75 pieces of side planking put in; hog chains repaired; hull calked throughout and painted with coal tar to light water line; new wash-down syphon installed. Cost, \$1,376.88.

Quarterboat Beta.—Rakes and sides calked; old paint on cabin burnt off and cabin repainted. Cost, \$54.70.

Barge No. 2.—Docked; entire new rakes; end of gunwales cut off and replaced with pieces of 6 inches by 14 inches by 7 feet; corner irons replaced with new bolts; 6 graving pieces put in sides; deck repaired; bitts refastened and sides, deck, and rakes calked; coal-tarred to light water line. Cost, \$170.53.

Barge No. 4.—Sides and rakes calked. Cost, \$68.63.

Barge No. 5.—Rakes and two seams on sides calked. Cost, \$19.30.

Barge No. 7.—Seven new rake plank; two graving pieces in sides; deck repaired and sides and rakes calked. Cost, \$85.85.

Barge No. 9.—Deck sheathed with old inch boards. Cost, \$48.91.

Barge No. 14.—Docked; bottom, rakes, and two seams on sides calked; four steel I beams with truss rods put in to reenforce deck to take machinery and boilers of Grader No. 3; floor timbers and bulkhead reinforced. Cost, \$580.97.

Barge No. 15.—Docked; one new bottom plank and 16 pieces decking put in; two new iron bitts put on; bottom, sides, and rakes calked; coal tarred to light water line. Cost, \$221.47.

Barge No. 17.—Docked; ten new rake plank and four graving pieces put in rakes; 60 linear feet of bottom planking renewed; the two knuckle seams and sides and rakes calked; coal tarred to light water line. Cost, \$237.64.

Barge No. 18 (cargo barge).—Eight athwartship truss rods put in; one graving piece in rake; sides and rakes calked; coal tarred to light water line; doors and shutters of cargo box repaired; and roof given a coat of tar. Cost, \$64.05.

Barge No. 19.—Gunwales repaired where crushed in and braces put in; sides and rakes calked. Cost, \$54.50.

Barge No. 21.—Four pieces decking and one piece covering board put in; one new bitt; sides and rakes calked. Cost, \$55.24.

Barge No. 23.—Docked; rakes and large seams and butts in bottom calked; deck repaired and gunwales reenforced where crushed in. Cost, \$135.68.

Barge No. 25.—Docked; ends of gunwales cut off and replaced with pieces of 6 by 14 inches by 7 feet; one piece of head block put in; 17 new rake plank; corner irons repaired and fastened with new bolts; deck repaired and sheathed; sides, rakes, and bottom calked; coal tarred to light water line. Cost, \$515.55.

Barge No. 30.—Docked; one broken bottom plank renewed. Cost, \$37.81.

Barge No. 32.—Rakes and sides calked. Cost, \$32.09.

Camel docks.—Each one of the four docked and calked; all large seams were over-calked with either dry cypress strips or tarred ratline; trunk on one dock renewed; hatches cut in each for cleaning out. Cost, \$412.50.

The Ram's pontoons.—Four of them entirely rebuilt. Cost, \$437.05.

Current repairs.—A great number of small items are included under this head, being too numerous to give in detail, and each too small to attribute to particular pieces of the plant. Work on small lighters, skiffs, etc., is included, the whole amounting to \$1,154.52.

Care of plant.—The cost of caring for the plant, while not in use during the year, both at the engineer depot in New Orleans, La., and near Natchez, Miss., was \$9,668.44, which includes the crews of two boats, watching, cleaning out, and whitewashing interior of barges, shifting lines, spars, etc.

Condition of plant.—Barge No. 8 is worthless and Nos. 5 and 9 nearly so. Barges Nos. 7, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 are now approaching the worthless stage. By extensive repairs their life may be prolonged for three or four years more. Barges Nos. 1, 2, 3, 6, 15, and 17 are in fair condition, and Nos. 4, 10, 11, 13, 14, 16, 28, 29, 30, 31, and 32 are in good condition. The quarter boats *Gamma* and *Delta* are in good condition and the others in fair shape. Of the steam craft the tug *Tilda* is now nearly 22 years old and is naturally worn out. To the stern-wheel launch *Ruby*, now 15 years old, the same remark will apply. The hull and machinery of the tug *General Comstock* are in good condition, but her boiler being over 20 years old should be repaired with one of modern type. The rest of the steam craft are in good order, requiring only the usual repairs to compensate for wear and tear to machinery, etc.

Conclusion.—For several years past the plant of the district has been worked to its capacity of about 50 acres of mattress work. It is evident therefrom that its present condition requires a large expenditure to maintain this standard of work. No piece, large or small, can be spared if it is desired to maintain the same rate of progress. A new tug to take the place of the *Tilda* is required; also a larger and more powerful stern-wheel boat to replace the *Ruby*. New barges to replace Nos. 5, 8, 9, and 12 should be built, and if the manufacture of concrete ballast continues, another large quarter boat is required. Of course if more than 50 acres of mattress work is contemplated, the entire plant will have to be increased in proportion.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Maj. GEO. MCC. DERBY,
Corps of Engineers, U. S. Army.

APPENDIX 4 C.

REPORT OF MR. L. E. LION, JUNIOR ENGINEER.

NEW ORLEANS, LA., May 1, 1902.

SIR: I have the honor to submit the following report on dredging in Lower Old River for the period from May 1, 1901, to May 1, 1902:

It became apparent in the latter part of July, 1901, that dredging would be required to maintain a channel of not less than 5 feet in Lower Old River, and the dredge *The Ram* was therefore put in readiness for the work. She took the field August 3, 1901, and dredging was begun at the mouth of the river on August 9, where the depth of water was less than 5 feet. Dredging was carried on until August 27. The mouth of the river was the only part which required dredging, as there was an ample depth of water in the other parts of the river during the entire year.

No trouble was experienced this year from the sloughing of the banks. This is a phenomenon which has given considerable trouble in the past, but has been almost entirely remedied by the annual drainage of the shallow lakes which border the banks. Only one of these lakes held much water this year. This one (Lake Chandler) was drained on August 28 at a cost of \$26.61. A small ditch was cut to start the flow of water, and as there was a great fall to the flow, the ditch soon enlarged into a considerable outlet.

On August 29, 1901, *The Ram* returned to New Orleans.

The following table gives detailed data pertaining to the dredging:

Number of cubic yards of material removed	57,333
Total cost of dredging (including journey to and from Old River)	\$2,147.65
Cost per cubic yard	\$0.0375

MISSISSIPPI RIVER COMMISSION.

171

Total length of channel dredged	feet..	1, 290
Average depth of cut	do....	8
Width of channel	do....	150
Average depth below water surface at which cutter head worked ..do....		14

The cost of dredging is subdivided as follows:

Administration	\$100. 00
Subsistence	606. 61
Wages	1, 064. 12
Fuel	246. 60
New plant	130. 32
Total	2, 147. 65

Repairs to the extent of \$884.89 were made on *The Ram* as follows:

New chimneys	\$216. 00
New disk, shaft, and liners for Edwards centrifugal pump	336. 00
Wire rope for hoisting cutter frame	60. 60
Repairs and alterations to suction of pump	132. 50
Belting	119. 99
New roller for swing chains	13. 50
Gauge glasses and rivets	6. 30
Total	884. 89

Very respectfully, your obedient servant,

L. E. LION, *Junior Engineer.*

Maj. GEO. MCC. DERBY,
Corps of Engineers, U. S. Army.

APPENDIX 4 D.

REPORT OF MR. W. E. KNOBLOCH, SUPERINTENDENT.

NEW ORLEANS, LA., *May 1, 1902.*

SIR: I have the honor to submit the following report on the levee work that has been done in the Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne levee districts for and during the period extending from May 1, 1901, to May 1, 1902:

Construction.—The amount of money available for levee work was limited to the unexpended balance of last year's allotment, and therefore this year's work consisted mostly in carrying out contracts which remained incomplete at the date of the last annual report.

Muck or base ditches.—All existing embankments, which were enlarged, were free from leaks, and as the foundation at Abadie, where a new levee has been built, was considered safe, no muck or base ditch was cut.

Supervision.—The method of supervision as reported in the last annual report was continued with two exceptions. After July 1, 1901, Mr. Paul Goddard acted, instead of Mr. John Klorer, as general inspector of the Barataria and Lake Borgne districts, and Mr. J. Z. Hardee, in addition to acting as general inspector of the Atchafalaya district, acted, instead of Mr. Lion, as general inspector of the Lower Tensas district.

Inspection.—During the year the entire levee line in the Fourth district was inspected twice by me. My inspection trips were made on a bicycle, and I was accompanied in each levee district by the general inspector of that district. On these trips the condition of the levee line and the banks was studied and discussed.

Protection against high water.—Up to this date the water has not been high enough to necessitate any protection work.

LOWER TENSAS LEVEE DISTRICT.

All work has been completed and there now remains no contract in force.

The building of a new levee by the State authorities at each of the following places—Claggett (644 R.), Vidalia (701 R.), Arnauldia (702 R.), and Arnauldia (702.5 R.)—has caused the abandonment of 6,159 linear feet of levee, embracing 87,700 cubic yards.

172 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Of the 130.68 miles of effective levee, there are on May 1, 1902, 497,743 linear feet, or 94.27 miles, built wholly or in part by the United States.

ATCHAFALAYA LEVEE DISTRICT.

Of the incomplete contracts at the date of the last annual report, Upper Grand Bay levee, sections 1-3 (808 R.), has been satisfactorily completed. Devall levee, section 3 (823 R.), and Cypress Hall levee (823 R.) still remain to be completed. No new contracts have been made.

Of the 128.26 miles of effective levee, there are on May 1, 1902, 464,953 linear feet, or 88.04 miles, built wholly or in part by the the United States.

LAFOURCHE LEVEE DISTRICT.

The incomplete contracts at the date of the last annual report have been completed, and as no new contracts were made there are no contracts in force.

The new levee built at Odier (950 R.) and a new levee built by the State authorities at each of the following places—Point Houmas (891 R.), Louisa (945 R.), Coopersville (944 R.), Alice Upper (945 R.), and Orange Grove (947 R.)—have caused the abandonment of 9,838 linear feet of levee, containing 214,210 cubic yards.

Of the 81.92 miles of effective levee on May 1, 1902, there are 359,944 linear feet, or 68.02 miles, built wholly or in part by the United States.

BARATARIA LEVEE DISTRICT.

Rodey Extension levee (1038 R.), which remained unfinished at the date of the last annual report, and Abadie levee (1022 R.), the only work since contracted for, have been completed and there now remains no contract in force.

On August 14, 1901, a storm caused the water to rise in the lower end of this district and caused the levee to be breached at Abadie (1022 R.), Wenck (1031 R.), and Buras Church (1034 R.), and washed away most of the levee from Fort Jackson to Venice (1040-1049 R.).

The United States built a new levee at Abadie (1022 R.) to replace the one which was so badly washed. In building this levee the standard section was changed and a section was adopted with a 2 to 1 land slope and a 6 to 1 river slope. It is expected that this section will withstand all wave wash.

The new levee built by the United States at Abadie (1022 R.) and a new levee built by the State authorities at each of the following places—Wenck (1031 R.), Buras Church (1034 R.), Fort Jackson to Booth (1040 R.), Booth to Leon Buras (1043-7 R.), and Leon Buras to Venice (1047 R.)—have caused the abandonment of 39,608 linear feet of levee, containing 41,360 cubic yards.

Of the 71.68 miles of effective levee on May 1, 1902, there are now 208,256 linear feet, or 39.44 miles, built wholly or in part by the United States.

PONTCHARTRAIN LEVEE DISTRICT.

During the year no levee construction has been done by the United States. St. Mary Chapel levee (859 L.) was contracted for on March 12, 1902, but owing to the river being bank full at this point no work has yet been undertaken.

Of the 125.73 miles of effective levee, there are on May 1, 1902, 519,799 linear feet, or 98.44 miles, built wholly or in part by the United States.

LAKE BORGNE LEVEE DISTRICT.

During the year no levee construction work was undertaken by the United States.

The construction of a new levee by the State authorities at each of the following places—Harlem (1002 L), Bellevue (1005 L), Nestor Canal to Burton (1020 L), Zetwoch (1024 L), Polites Canal (1030 L), Baril to Bick (1035 L), Brophy to Bick (1036 L), Bick to O'Brien (1036 L), Moran-Brophy section (1036 L), Moran (1037 L), Arms (1038 L), and Arms Extension (1038 L)—has caused the abandonment of 18,524 linear feet of levee, containing 46,918 cubic yards.

Of the 71.42 miles of effective levee, there are on May 1, 1902, 173,517 linear feet, or 32.86 miles, which were built wholly or in part by the United States.

ABANDONED LEVEES.

The following is a table of the previous history of each length of levee which has been abandoned by the construction of new levees from May 1, 1901, to May 1, 1902:

Name.	Miles below Cairo.	District.	Length (feet).	By whom built.	When built.	By whom enlarged.	When enlarged.
Claggett	644 R.	Lower Tensas.	380	State	1900		
Do	644 R.	do	1,400	do	1882	United States.	1898
Vidalia	701 R.	do	1,139	Riparian owners.	Previous to 1866.	State	1891
Arnauldia	702 R.	do	1,600	State	1890	United States.	1895
Do	702.5 R.	do	1,640	do	1890	do	1895
Point Houmas	891 R.	Lafourche	445	do	1900		
Do	891 R.	do	2,762	do	1879		
Louisa	943 R.	do	142	U. S.	1893		
Do	943 R.	do	1,510	State	1886	State	1893
Coopersville	944 R.	do	1,489	do	1886	do	1897
Do	944 R.	do	182	U. S.	1893	do	1897
Alice, Upper	945 R.	do	179	U. S.	1893		
Do	945 R.	do	1,586	State	1881	United States.	1896
Orange Grove	946 R.	do	1,359	do	1881	State	1899
Odier	960 R.	do	156	do	1882		
Abadie	1,022 R.	Barataria.	1,244	do	1882	United States.	1899
Wenck	1,031 R.	do	1,974	do	1887		
Buras Church	1,034 R.	do	565	do	1885		
Fort Jackson to Booth.	1,040 R.	do	13,425	Not known.	Not known.		
Booth to Leon Buras.	1,043 R.	do	15,565	do	do		
Leon Buras to Venice.	1,047 R.	do	6,885	do	do	United States.	
Harlem	1,002 L.	Lake Borgne.	180	State	1900		
Do	1,002 L.	do	1,072	Not known.	Not known.	United States.	1897
Bellevue	1,005 L.	do	2,387	do	do	State	1896
Nestor Canal to Burton.	1,020 L.	do	2,240	Riparian owners.	do		
Zetwoch	1,024 L.	do	1,460	do	do		
Polite's Canal	1,034 L.	do	310	do	do		
Bark to Bick	1,035 L.	do	4,960	do	do		
Brophy to Bick	1,036 L.	do	1,735	do	do		
Bick to O'Brien	1,036 L.	do	425	do	do		
Moran (Brophy section).	1,037 L.	do	1,245	do	do		
Moran	1,038 L.	do	2,510	do	do		
Arms							
Arms extension							

Of the 1,790 linear feet of levee abandoned by the building of a new levee at Claggett (644 R.), 380 feet were built by the State authorities in 1900 as a wing, and were not expected to have a life of twenty years; the other 1,400 feet were built in 1882, and had a life of twenty years. The 1,400 feet built in 1882 were enlarged by the United States in 1898. The cost of enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The levee abandoned by the construction of a new levee at Vidalia (701 R.) was built by the riparian owners previous to 1866, and enlarged by the State authorities in 1891. The cost of the enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The levees abandoned by the building of new ones at Arnauldia (702 R.) and (702.5 R.) were built by the State authorities in 1890 and enlarged by the United States in 1895. The abandonment of these levees was not due to any immediate danger of their caving into the river, but on account of a lack of material on the river side with which to enlarge them.

The levee abandoned by the construction of a new levee at Point Houmas (891 R.) was built by the State authorities more than twenty years ago, except a wing of 445 linear feet, which was built in 1900.

The new levee built at Louisa (943 R.) caused the abandonment of 142 linear feet of a wing of a levee built by the United States in 1893, and 1,310 linear feet of levee built by the State authorities in 1886, and enlarged by them in 1893. The cost of the enlargement per year of the service of the enlarged levee was less than one-twentieth of the cost of the new levee. The life of the levee was only sixteen years.

The 1,671 linear feet of levee abandoned by the building of a new levee at Coopersville (944 R.) were enlarged by the State authorities in 1897. Of this length a wing

of levee 182 feet long was built by the United States in 1893; the remaining 1,489 linear feet of levee were built by the State authorities in 1886. The cost of the enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee. The life of the abandoned levee was only sixteen years.

Of the 1,689 linear feet of levee abandoned at Alice Upper (945 R) 179 linear feet were built by the United States as a wing, and the other 1,510 linear feet were built by the State authorities more than twenty years ago, and enlarged by the United States in 1896. The cost of the enlargement per year of the service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The new levee built at Orange Grove (946 R) caused the abandonment of 1,360 linear feet of levee built by the State authorities more than twenty years ago and enlarged by them in 1889. The cost of the enlargement per year of service of the enlarged levee was less than one-twentieth of the cost of the new levee.

At Odier (930 R) a new levee was built to improve the alignment of the levee line, and its cost was no greater than what would have been the cost of enlarging the abandoned levee. The 136 linear feet of levee abandoned were built by the State authorities in 1882.

The old levees abandoned by the construction of new levees at Abadie (1022 R), Wenck (1031 R), Buras Church (1034 R), Fort Jackson to Booth (1040-1043 R), Booth to Leon Buras (1043-1047 R), and Leon Buras to Venice (1047 R) were due to the washing away of parts of these levees during a storm.

The new levee built at Harlem (1002-L) caused the abandonment of 180 linear feet of a wing of a levee built by the State authorities in 1900 and 1,072 linear feet of levee of which nothing is known as to its original construction. These 1,072 linear feet of abandoned levee were enlarged by the United States in 1897. The cost of the enlargement of this abandoned levee per year of its service was less than one-twentieth of the cost of the new levee.

Nothing is known of the date of the original construction of the 2,587 linear feet of levee abandoned by the building of a new levee at Bellevue (1005 L). This abandoned levee was enlarged by the State authorities in 1895. The cost of the enlargement per year of the service of the enlarged levee was less than one-twentieth of the cost of the new levee.

The levees abandoned by the building of a new one at each of the following places: Nestor Canal to Burton (1020 L), Zetwoch (1024 L), Polites Canal (1034 L), Baril to Bick (1035 L), Brophy to Bick (1035 L), Bick to O'Brien (1036 L), Moran-Brophy Section (1036 L), Moran (1037 L), Arms (1038 L), and Arms Extension (1038 L), were built by riparian owners, and nothing is known of the history of their construction.

Very respectfully, your obedient servant,

W. E. KNOBLOCH, *Superintendent.*

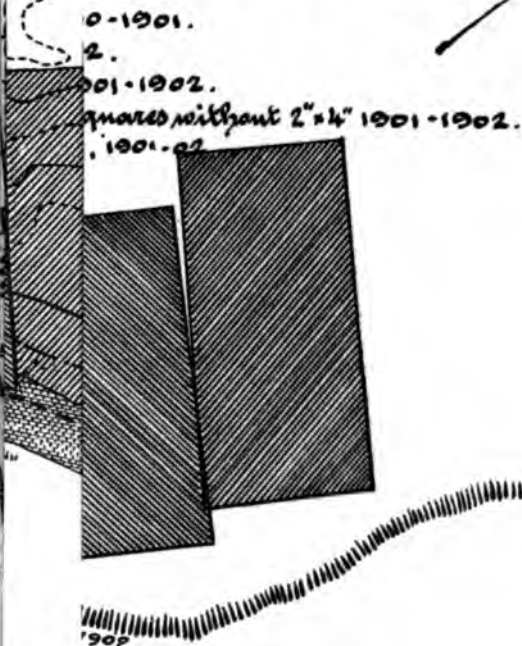
MAJ. GEO. MCC. DERBY,
Corps of Engineers, U. S. A.

Plate I.

Mississippi River Improvement
 Fourth District
 In charge of
 Wm. C. Deby, Corps of Engineers, U.S.A.
 Harbors of
 St. Charles & Vidalia.
 Douglas, Asst. Engr. in local charge.
 Lower part of
 Giles Bend.
 Scale 1:2000

Wares from Survey of Vigo, 1901 & Feb. 1902, and
 water plane 43.0 ft. above Cairo datum.
 To accompany Annual Report of 1901-1902.

Frederick
 Major of Engineers, U.S.A.



N. A. Morano, Del.

Plate II.

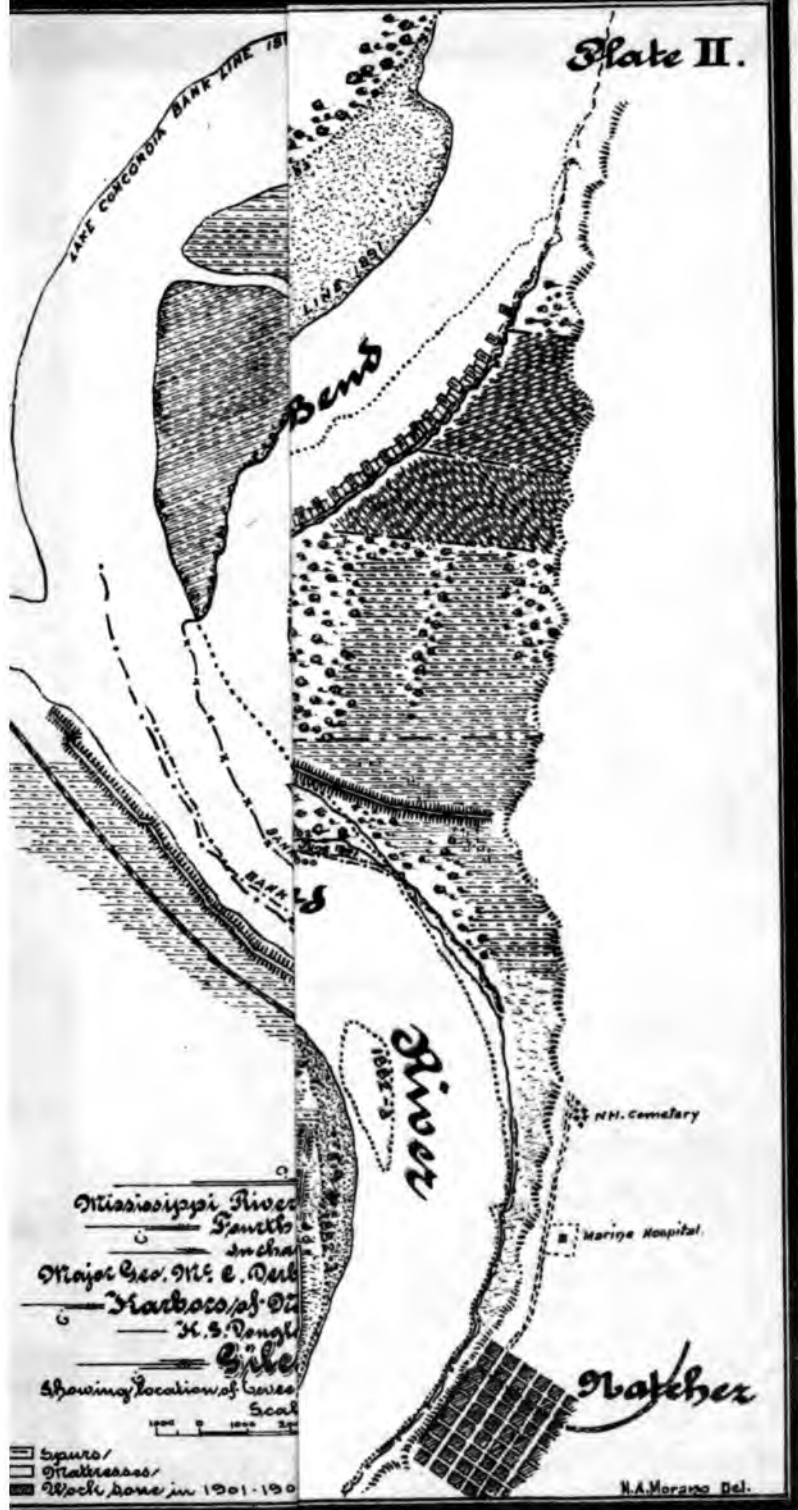


Plate III.



35'

Major

on the
edge.

ed 54'



N.A. Morayo Del.

■

Vertical line segment

Horizontal line segment

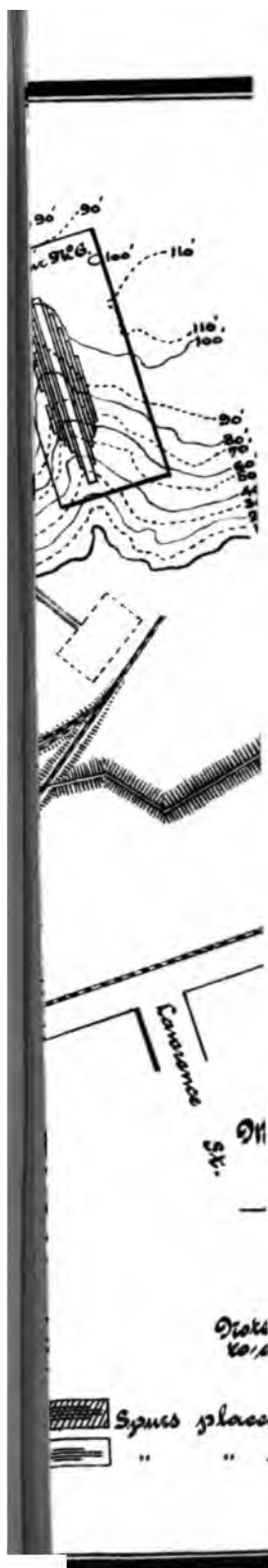
River

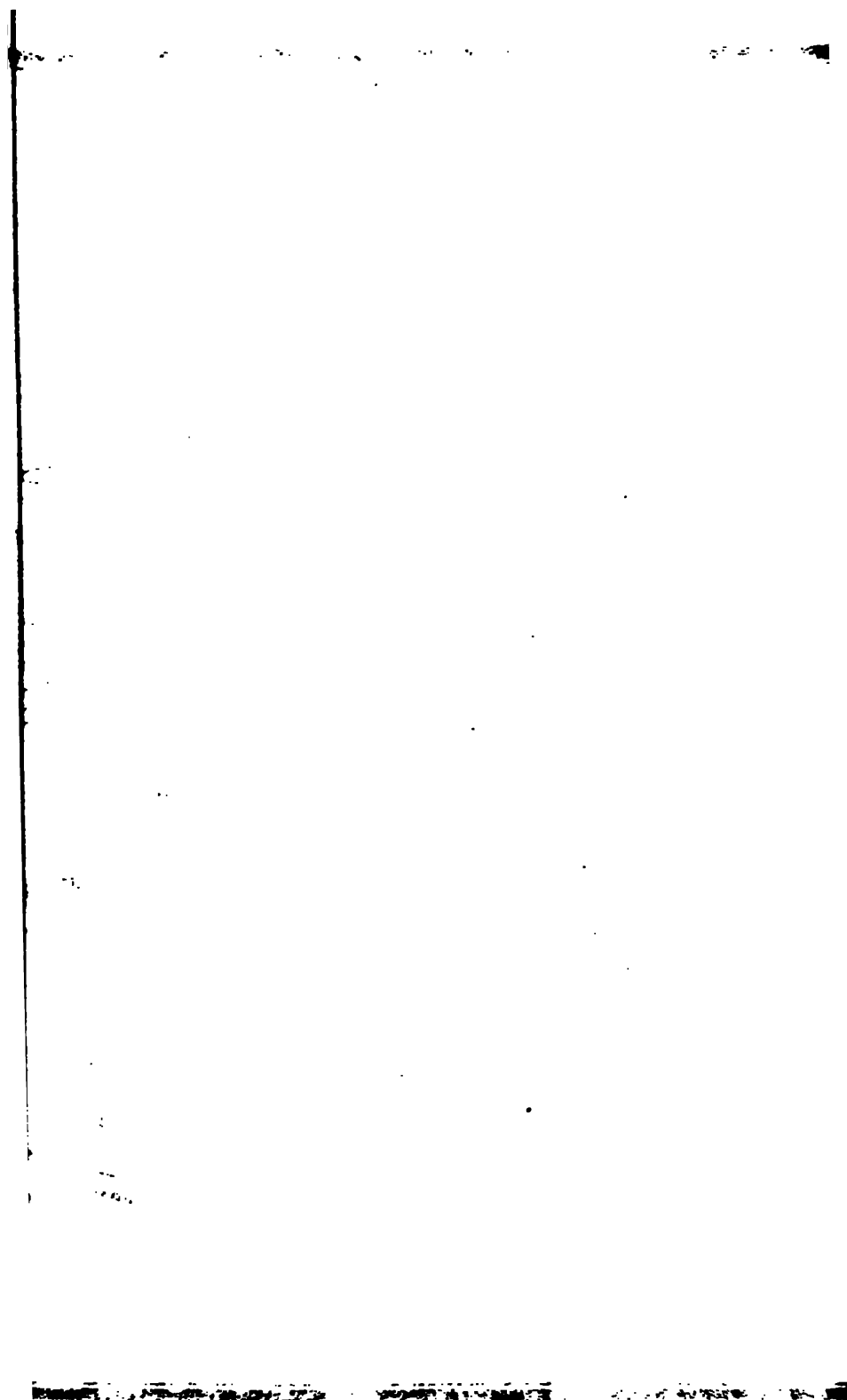
120' 110' 100'

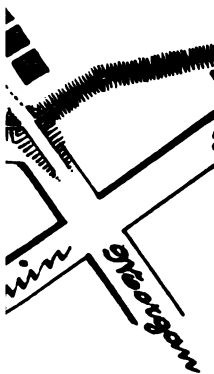
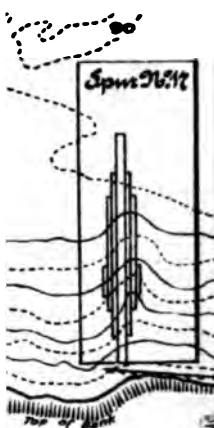


oad.

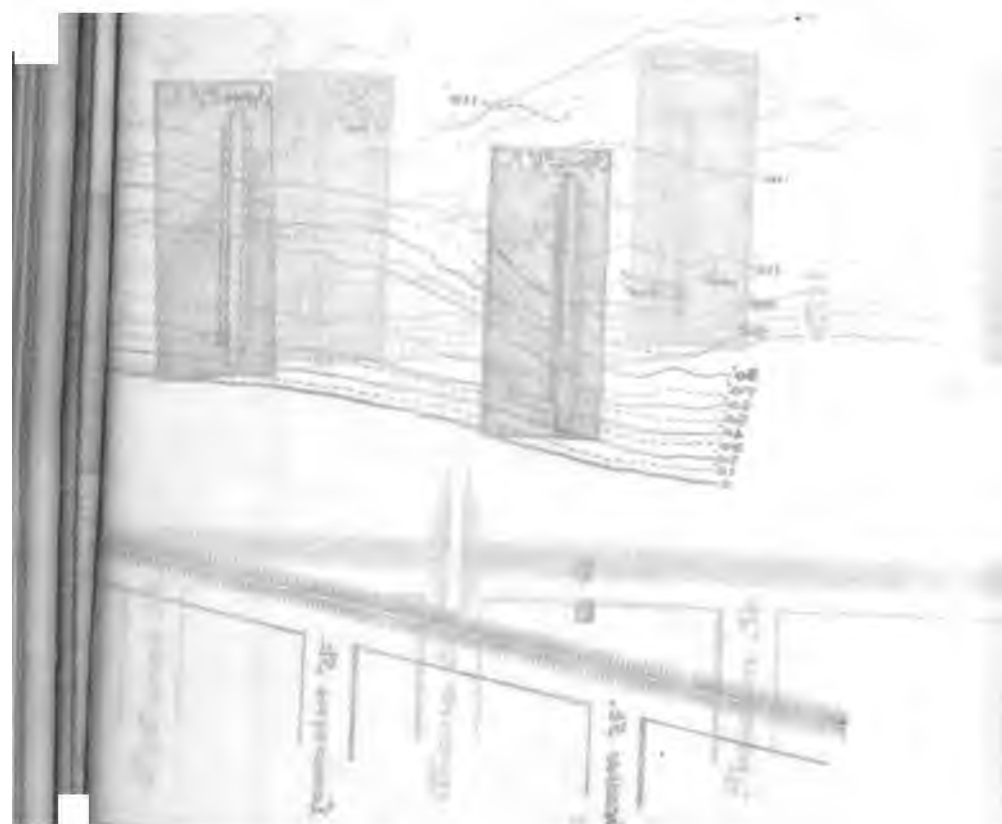


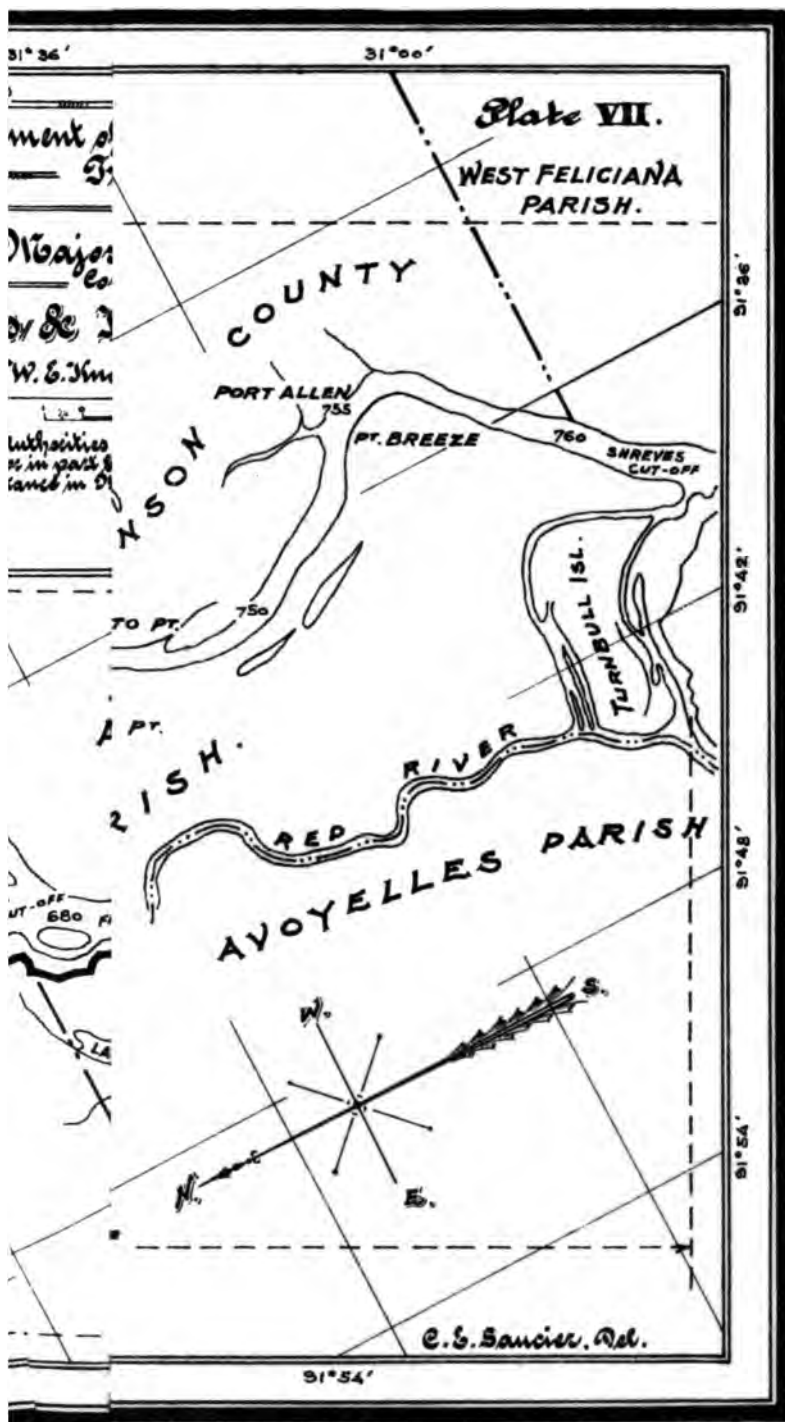






[Faint, mostly illegible handwritten text, possibly a list or notes, covering the right side of the page. Some words like 'Spm 26/17' and 'Top of Hill' are visible, matching the labels in the diagrams.]









1. The first part of the map shows a lake, a road, and a building labeled "BAPTIST". The map includes contour lines and a scale bar at the top.

2. The second part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

3. The third part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

4. The fourth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

5. The fifth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

6. The sixth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

7. The seventh part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

8. The eighth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

9. The ninth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

10. The tenth part of the map shows a road, a building labeled "BAPTIST", and a lake. The map includes contour lines and a scale bar at the top.

Mississippi River.
District

Charge of

W. C. Derby.

Engineers, U. S. A.

Major George Dist

Suplt. in local charge.

of Miles

To accompany Annual R

Skates.

Cairo.

Free

Major of Engineers

EVEE DIST



Abadia, 1901-1902
NEW

CT

29° 18' 89° 48'

89° 24'

28° 54'

Plate IX.

F



85° 00'

85° 06'

85° 12'

85° 18'

ANNUAL REPORT OF THE MISSOURI RIVER COMMISSION FOR THE
FISCAL YEAR ENDING JUNE 30, 1902.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 27, 1902.

SIR: The Missouri River Commission has the honor to submit this its annual report for the fiscal year ending June 30, 1902.

The personnel of the Commission has been changed during the year by the relief of Lieut. Col. T. H. Handbury, Corps of Engineers, and the appointment in his place of Maj. Thomas L. Casey, Corps of Engineers, to date from January 22, 1902.

No assignment was made to the office of secretary of the Commission, vacated on April 27, 1901, by the relief of Capt. Charles Keller, Corps of Engineers, by Special Orders, No. 88, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1901, the duties being performed by the president of the Commission.

In the river and harbor bill approved June 13, 1902, the act of Congress of July 5, 1884, constituting the Missouri River Commission, was repealed, to take effect June 30, 1902, upon which date the Commission ceases to exist. This is, therefore, its last annual report. Owing to the failure of the river and harbor bill containing appropriations for the fiscal year ending June 30, 1902, and the small balances remaining for works under the jurisdiction of the Commission, no work has been done since the last annual report other than that for the care of the plant, small repair work, and necessary office work. The balances available July 1, 1901, were:

Missouri River.....	\$14,359.46
Osage River.....	9,985.87
Gasconade River.....	1,488.96

These small balances precluded the possibility of any work of improvement being prosecuted, and required careful economy to maintain a very small organization for care of plant, records, and office work to the end of the fiscal year. One meeting of the Commission was held June 27, 1902.

The office was removed during the year to less commodious quarters to effect a saving in rental.

During the year, certain work of bank protection on the Missouri River has been done by the Chicago, Burlington and Quincy Railway Company in the bend above Rulo, Nebr., and by the Chicago and Alton Railway Company in the bend near Cambridge, Mo. The first was under the general supervision of a Government agent named by the president of the Commission, but paid by the company. The company covered 7,975 linear feet of bank with revetment in continuation of the work done under the Commission in 1900 and 1901. For the work in Cambridge bend some of the Government plant was used, being loaned by the direction of the Secretary of War. The company

covered 8,250 linear feet of bank with revetment in continuation of their similar work built in 1889 and on which the Commission had done some repair and reenforcement work in 1898 and 1899. A description of these works will be found in the accompanying report of Mr. S. Waters Fox, assistant engineer, Appendix D.

The Commission was organized by act of Congress approved July 5, 1884, after considerable work had been done in the river in scattered localities; and it was believed that Congress had determined upon a thorough improvement of the river to make it a useful artery of commerce, and would make provision for carrying the work forward with all speed. The membership as first appointed by the President of the United States was composed as follows: Lieut. Col. C. R. Suter, Corps of Engineers, U. S. Army; Maj. Alexander Mackenzie, Corps of Engineers, U. S. Army; Maj. Oswald H. Ernst, Corps of Engineers, U. S. Army; Mr. Garland C. Broadhead, of Pleasant Hill, Mo., Mr. William Broatch, of Omaha, Nebr.

First Lieut. W. L. Fisk, Corps of Engineers, U. S. Army, was assigned as secretary of the Commission.

During the eighteen years the personnel has been changed at various times and included, in addition to the present membership, Maj. Chas. J. Allen, Corps of Engineers, U. S. Army; Lieut. Col. William R. King, Corps of Engineers, U. S. Army; Maj. William H. Heuck, Corps of Engineers, U. S. Army; Maj. Thomas H. Handbury, Corps of Engineers, U. S. Army; Maj. William L. Marshall, Corps of Engineers, U. S. Army; Richard S. Berlin, of Omaha, Nebr.; and the following officers have served as secretary: First Lieut. W. L. Fisk, Corps of Engineers, U. S. Army; Capt. Theodore A. Bingham, Corps of Engineers, U. S. Army; Capt. J. C. Sanford, Corps of Engineers, U. S. Army; Lieut. James McIndoe, Corps of Engineers, U. S. Army; Capt. H. M. Chittenden, Corps of Engineers, U. S. Army; Capt. G. D. Fitch, Corps of Engineers, U. S. Army; Capt. Charles Keller, Corps of Engineers, U. S. Army.

Lieut. Col. (now Colonel) C. R. Suter was first designated as president and remained in that position until January 14, 1896, when Lieut. Col. (now Colonel) Amos Stickney succeeded to the position which he has held to the present time.

The policy of the Commission in the work of improving the river has been practically unchanged from the beginning of its existence to the end. It was determined by the experience previously gained upon the river, and its wisdom has been more and more demonstrated year by year as the work progressed, and it is believed that no person who has had experience in dealing with the Missouri River and is competent to judge questions the wisdom of that policy or believes that the work can be done with due economy and efficiency in any other way. The policy may be stated in a few words to be a continuous, progressive control of the river, contracting it where necessary, giving the channel proper direction and securely holding it in place. Unfortunately for the improvement, the Commission for the greater part of the time of its existence has not been permitted to carry out its policy, except with such limited amounts of the yearly appropriations as to render progress exceedingly slow. On that part of the river in the first reach where continuous work was done, under what is called systematic improvement, the results reached were remarkable. A continuous channel of not less than 6 feet depth at low water was obtained

in a stretch of about 45 miles of river, on what was originally one of the worst parts of the river, in the vicinity of the mouth of the Osage. In addition to this forming of a channel, much new land was formed, and much land protected from destruction by the river. To illustrate this, it may be stated that in a distance of only 18 miles in the vicinity of Jefferson City the area of new land formed by the rectification works amounted to 5,500 acres, and the area of land protected was 12,800 acres. Computing this at a fair price of \$50 per acre, the sum of \$915,000, or over \$50,000 per mile of river, was added to the wealth of the country as incidental to the improvement of navigation.

There is hardly a doubt that equal results would be obtained on the whole river from its mouth to Sioux City, a distance of 800 miles, under a thorough systematic improvement.

The river flows along or through seven States, with a length of over 2,400 miles. Between Sioux City and its mouth, a distance of 800 miles, it borders forty-six counties. In these forty-six counties the population aggregates 1,473,570, and on its banks there are over one hundred cities and towns, including one city of over 160,000, two of over 100,000, one of over 50,000, four of over 30,000, 25,000, 20,000, and 15,000, respectively, three of more than 7,000 and less than 10,000, five of more than 2,500 and less than 5,000, and twenty of more than 2,500 and less than 2,500. It has a volume of flow at all times sufficient for channels of not less than 5 feet depth at Sioux City, and 8 to 10 feet at the mouth.

In its present condition it has very little commerce for the reason that the difficulty of navigation will not justify the running of boats, and insurance can not be obtained, except at exorbitant rates. No growth of commerce could be expected until the river is opened to the mouth to give it an outlet.

If the amount of its existing commerce is to be used as the measure of its worthiness for improvement, it might as well, as has been facetiously proposed, be wiped off the map of internal improvements. If its capacity for improvement and the possibilities of its use as a highway for cheap transportation for a very large section of country and a numerous population be considered, its worthiness takes high rank.

In view of the widespread misapprehension of the objects of the Missouri River appropriations, as evidenced by some criticism of the Commission by the press, and to a certain extent in Congress, growing out of the report of the River and Harbor Committee presented to the House of Representatives with the river and harbor bill, the Commission deems it incumbent upon it to correct this misapprehension and to submit the following statement of facts:

The significance given to certain phraseology in the report of the committee seems to do great injustice to the work of the Commission and to the interests involved in the improvement of the river. From some of the unqualified statements it might be inferred that the money appropriated by Congress in the interests of navigation for carrying on the operations of the Commission has been used without Congressional authority for objects other than the improvement of navigation.

The Commission sees no reason why the committee should have intended that such a construction should be placed upon the language of its report, but, nevertheless, such construction has been given it.

An examination of the river and harbor and sundry civil acts that

have been enacted since the organization of the Missouri River Commission in 1884 will show that a very large proportion of the total appropriations for work on the Missouri River under the Commission has been allotted by Congress to localities apparently for the protection of private and corporate interests not wholly connected with navigation.

The Commission has never been called upon by Congress to express its views as to the propriety or necessity for these legislative allotments for work which does not come within the approved project for the general improvement of the river, or the scheme for a progressive execution of the work under this project, but which have been placed under the charge of the Commission.

The accompanying extracts from the annual reports of the Commission, to which attention is specially invited, show that from the time of its first annual report to its last the Commission has steadily kept in view the general and radical improvement of the river, that it might become a useful means of providing cheap transportation for the benefit of the vast country tributary to it, and it has repeatedly urged upon Congress to permit appropriations made for improving Missouri River to be applied to carrying out the approved project for the systematic improvement of the navigation of the river, and to make special appropriations, if it saw fit, for the benefit of special localities and interests.

The tabular statement hereto annexed shows the objects to which was directed the expenditure of funds provided by each of the appropriation acts since the creation of the Commission. This table also shows exactly how these funds have been allotted and expended by the Commission. Wherever the Commission has been required by Congress to expend money, apparently solely for the purpose of protection, the Commission has endeavored so to plan the works as to cause them ultimately to become part of the general project for the improvement of navigation. This, unfortunately, has not always been possible on account of there being no control of the unimproved river above detached pieces of protection work.

The table shows that Congress specifically directed the expenditure of funds for local work and for work unconnected with the general improvement of the river to the amount of \$2,218,000. In addition to this, each piece of local work has required expenditures for maintenance far greater than would have been the case had it been part of the systematic work. This expenditure for maintenance, while not specifically ordered by Congress, was a necessary and logical consequence of Congressional policy, and the Commission has not felt itself at liberty to avoid the legitimate consequences of the system imposed upon it by the lawmaking body.

In addition, the policy of ordering work at localities scattered over the river from its mouth to Omaha has caused the Commission unusually high expenses for plant, superintendence, clerical hire, and traveling expenses, which extra expenses have been paid largely from the balance of funds available for systematic work.

Since the organization of the Commission \$7,150,000 have been appropriated by Congress for work on the river under the Commission. Of this amount \$240,000 was expended on the part of the river above Sioux City, no longer in charge of the Commission. As result of

direct mandate of Congress, \$2,164,364.25 was expended for work at detached localities, which, by themselves, could have no effect upon the improvement of general navigation or the development of commerce. Three hundred and eighty thousand and eighty-two dollars and twenty-nine cents was expended upon snagging operations which, upon the Ohio, the Upper Mississippi, and Lower Mississippi, are paid out of special continuing annual appropriations. Four hundred and sixty-nine thousand five hundred and eighty-five dollars and ninety-seven cents was expended for surveys and gauges. Eight hundred and fifty-five thousand seven hundred and sixty-five dollars and fifty-five cents was expended for plant, office work, expenses of Commission, and all other incidental expenses, leaving but \$3,280,201.96, extending over eighteen years, to be applied to the effective, progressive, and systematic improvement of the river, part of this amount being expended near Kansas City and the remainder in the first reach. The expenditure of this amount in systematic work produced results in channel improvement and river regulation that were certainly remarkable, and had the work been maintained and extended to the mouth of the river the benefit to commerce would have been beyond question. In the first reach the work was nearly completed for 45 miles and the channel depth increased from 2½ to 6 feet.

Of the advisability and desirability of carrying on the systematic improvement of the river there can be little doubt. In former days, before the advent of railways and while the resources of the valley in commodities seeking market were undeveloped, there was a large and profitable commerce on the river, because freight rates could be made high enough to cover the large probability of wreck of the vessel, the full value of the boat frequently being earned in a single trip.

The danger and difficulty attending navigation on the river, which still exists, is attested by the wrecks of some three hundred steamboats now lying imbedded in its sand.

Since the spread of railway lines through the country adjoining and tributary to the Missouri River, freight rates have declined, while the navigation of the river has not grown safer to an equal degree, and as a consequence river traffic has largely diminished, and what little exists to-day is practically only as a feeder to the railways. But should the fact that there is practically no commerce on the river in its present condition be accepted as sufficient cause for its abandonment? It is understood that having so improved a river that navigation is possible, the question of the advisability of maintaining and enlarging its facilities for commerce should be based upon the relative magnitude and growing demands of its commerce, but up to this time the Missouri River has not been so improved upon a sufficient length to permit any considerable use of it. There are no facts to disprove the claims of those who, after much study and experience, maintain the belief that its improvement can be accomplished at a reasonable cost, and would be quickly followed by a commerce amply justifying the outlay.

The physical characteristics of the stream are such that there can be no commerce until a reach of considerable length extending to the mouth of the river is improved and rendered stable. The improvement of disconnected reaches some distance from the mouth will not open the river to navigation. The work must be systematic and con-

tinuous to its mouth, and while this is being done no considerable commerce can exist.

Let us take, for illustration, the construction of the Nicaragua Canal, which is estimated to cost over \$200,000,000. After expending the enormous sum of \$100,000,000 upon it, the commerce upon it would not be cited as not justifying further work.

As incidental to the improvement of the river for navigation, and not made apart from it, the security given to the river fronts of many cities and towns now suffering damage, the value of land incidentally reclaimed, and the increase and stability of value given to lands incidentally protected would add enormously to the wealth and to the building up of the valley.

The Commission does not feel called upon to further remark upon the advisability of the improvement of the Missouri River than to say that there are perhaps not many projects upon which the General Government is now engaged more certain to produce large returns than would result from the proper improvement of the Missouri River.

With regard to the execution of work, it matters little whether it be carried on by a commission or by a single officer under the War Department. The actual work provided for by Congress would go on in about the same way, but commissions, boards, and corporations possess certain advantages over individuals, especially in outlining policies, and in all matters where they come into contact with the general public. The public has more confidence in and respect for such bodies, which are, therefore, better able to resist undue pressure that individuals might find hard to make headway against. Such pressure has not been wanting in the past history of the Commission, and its recorded reports show how faithful it has been to its trust.

The additional cost to the work entailed by the organization of the Commission has probably been overestimated by those uninformed. Its whole cost for salaries of the two civilian commissioners, traveling expenses and extra clerical work of all kinds, does not exceed \$10,000 annually, which is not more than 1 per cent of the amount that the Commission could profitably expend in an energetic, systematic improvement, if such were provided for.

With regard to the repeal of the act creating the Commission, this may be said: Congress created the Commission with the supposed purpose of making an extensive and effective improvement of the river. The Commission has carried out this purpose with zeal and with fidelity to the extent that was possible under Congressional restrictions, and a much greater development of the general improvement of the river would have been attained if the money appropriated for the river could have been expended for the purpose. As Congress has not deemed it advisable to continue the work upon a scale and in a manner to make an effective general improvement, there is, of course, no longer necessity for the existence of the Commission.

For commercial statistics during the year 1901 see report of Assistant Engineer A. H. Blaisdell, Appendix B.

A brief description of the various works constructed under the direction of the Commission is appended, with maps of the localities, Appendix A.

OSAGE RIVER.

A history of the improvement work on this river since the adoption of the original project in 1871 may be found in the Annual Reports of the Chief of Engineers for 1900 and 1901.

Little work was done during the fiscal year 1902 except care taking, and the authorized lock and dam, situated about 7 miles above the mouth, remains in an incomplete state.

The Commission renews its recommendation that after the completion of Lock and Dam No. 1 the method of improvement of the river by canalization be suspended, and that further improvement be limited to open channel work and the removal of obstructions.

For details of work done see report of Assistant Engineer S. Waters Fox, and for commercial statistics, see report of Assistant Engineer A. H. Blaisdell, Appendixes E and B, respectively.

GASCONADE RIVER.

There was no work done on this river during the fiscal year except that connected with the preservation of property.

The river is worthy of improvement by the method which has been practiced since the original project adopted in 1880, consisting in the construction of wing dams and training walls on the shoals to concentrate the flow of water, and the removal of snags and other obstructions to navigation, Appendix F.

For commercial statistics see report of Assistant Engineer A. H. Blaisdell, Appendix B.

RECOMMENDATIONS AND ESTIMATES.

MISSOURI RIVER.

The Commission makes the following recommendation with regard to future appropriations, viz: That \$1,000,000 per annum be appropriated for a thorough systematic improvement of the river without any diversion of the funds to any other purpose until the improvement of the first reach, from near Jefferson City to the mouth of the river, be completed, which it is believed can be accomplished for between \$3,000,000 and \$3,500,000, the question of the extension of the improvement above the first reach to be decided later.

And the Commission desires to state that it makes no recommendation for any appropriation whatever other than for the operation of snagboat, unless it can be made in a manner to permit of its application to a thorough systematic improvement of the river.

Work for the protection of various localities in advance of the general and continuous improvement at those localities does not form, and has not formed, part of the general scheme of the Commission. Such work is undoubtedly urgently needed, and in many places, such as the vicinity of cities and towns, might be fairly considered a proper object for public expenditures. Each case, however, should be decided upon its merits, and appropriations therefor that may be decided upon by Congress should be separate and distinct from appropriations for the general improvement of the river.

182 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

A general provision for operating snagboat upon the Missouri River is recommended, similiar to the provisions made for other rivers, so that the Secretary of War may be authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of \$35,000.

OSAGE RIVER.

It is confidently expected that Lock and Dam No. 1 will be completed during the next fiscal year and provisions for its operation and maintenance should be made.

For continuing the improvement of the river under the original project, by the open channel method and removal of obstructions, an annual appropriation of \$25,000 is recommended.

GASCONADE RIVER.

The amount recommended for the improvement under the existing project is \$15,000 per year.

Money statements.

IMPROVING MISSOURI RIVER.

July 1, 1901, balance unexpended	\$23, 139.86
Refunded on account of overpayment.....	143.45
Amount appropriated by river and harbor act approved June 13, 1902.	175, 000.00
	<hr/>
June 30, 1902, amount expended during fiscal year	198, 283.31
	22, 684.78
July 1, 1902, balance unexpended	175, 598.53
July 1, 1902, outstanding liabilities.....	528.58
July 1, 1902, balance available	175, 069.95
<hr/>	
{ Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902: For works of improvement.....	
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	
	1, 000, 000.00

IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.

July 1, 1901, balance unexpended	\$10, 049.62
Amount appropriated by river and harbor act approved June 13, 1902 ..	30, 000.00
	<hr/>
June 30, 1902, amount expended during fiscal year	40, 049.62
	4, 125.55
July 1, 1902, balance available	35, 924.07
<hr/>	
{ Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902, for works of improvement.....	
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	
	25, 000.00

MISSOURI RIVER COMMISSION.

183

IMPROVING GASCONADE RIVER, MISSOURI.

July 1, 1901, balance unexpended	\$1,488.96
Amount appropriated by river and harbor act approved June 13, 1902 ..	10,000.00
	<hr/>
	11,488.96
June 30, 1902, amount expended during fiscal year	1,229.42
	<hr/>
July 1, 1902, balance available	10,259.54
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902, for works of improvement	15,000.00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Respectfully submitted.

AMOS STICKNEY,
Colonel of Engineers, U. S. Army,
President Missouri River Commission.

GARLAND C. BROADHEAD.

C. L. CHAFFEE,

W. L. MARSHALL,

Major of Engineers, U. S. Army.

THOS. L. CASEY,

Major of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,

Chief of Engineers, U. S. Army.

Table showing appropriations and allotments made by Congress and actual expenditures of Missouri River Commission since its organization.

APPROPRIATIONS.

[Under continuing contract system, after 1892, except act March 3, 1899, river and harbor, for \$100,000.]

	July 6, 1884, \$640,000.	Aug. 5, 1886, \$375,000.	Aug. 11, 1888, \$1,000,000.	Feb. 22, 1890, \$75,000.	Sept. 19, 1890, \$800,000.
	Balance from act Aug. 2, 1882, \$12,844.39.	Final dis- tribution by Com- mission.	Allotted by Congress.	Final dis- tribution by Com- mission.	Final dis- tribution by Com- mission.
Survey above Falls	\$15,000.00				
Improvement above Sioux City	125,000.00				
Office and Commission expenses and dis- trict officers above Sioux City	11,500.00				
Improvement:					
At Sioux City					
At Omaha and Council Bluffs		Mentioned.	\$100,000.00		
At Plattsmouth		Mentioned.	150,000.00		
At Nebraska City		Mentioned.	50,000.00		
At Rufo			75,000.00		
At St. Joseph	97,983.20		50,000.00		
At Atchison		Mentioned.	65,000.00		
At Leavenworth		Mentioned.	75,000.00		
At mouth Kaw River		Mentioned.	75,000.00		
At Kansas City			60,247.09		
At Miami	279,361.96		60,247.09		
At Arrow Rock and Nigger Bend			94,150.00		
Miscellaneous harbors and localities at discretion of Commission			19,749.03		
Improvement in First Reach			35,948.26		
Snagging operations					
Expenses of office and Commission	20,000.00				
Plant and repairs to same	135,564.84				
Surveys, gauges, physical data, and pub- lications	50,000.00				
	140,000.00	375,000.00	775,000.00	75,000.00	800,000.00
	10,861.59		1,000,000.00	208,000.00	

a Not distributed in tabulation of expenditures.

TABLE SHOWING APPROPRIATIONS AND AMOUNTS MADE BY CONGRESS AND ACTUAL EXPENDITURES OF DISTRICT RIVER COMMISSION SINCE ITS ORGANIZATION—Continued.

APPROPRIATIONS—Continued.

	July 13, 1892, \$600,000.		Mar. 3, 1893, \$750,000.		Aug. 18, 1894, \$750,000.		Mar. 2, 1895, \$750,000.	
	Allotted by Congress.	Final distribution by Commission.	Allotted by Congress.	Final distribution by Commission.	Allotted by Congress.	Final distribution by Commission.	Allotted by Congress.	Final distribution by Commission.
Improvement:								
At St. Louis City			\$50,000.00		\$50,000.00			
At St. Louis City								
At Omaha and Council Bluffs		\$80,000.00		\$16,800.00	75,000.00	\$75,000.00	\$40,000.00	
At St. Joseph		30,000.00		30,000.00		22,500.00		
At St. Joseph and other localities in Missouri					50,000.00			
At Atchison					35,000.00	35,804.18		
At Leavenworth						27,500.00		
At Kansas City		5,000.00						
Miscellaneous harbors and localities at discretion of Commission								
Improvement in First Reach	A portion.	180,000.00		599,200.00		450,000.00		\$510,000.00
Snagging operations		35,000.00		19,000.00		40,000.00		40,000.00
Expenses of office and Commission		12,500.00		20,000.00		21,500.00		25,000.00
Plant and repairs to same		250,000.00						
Surveys, gauges, physical data, and publications		57,500.00		15,000.00		28,500.00		35,000.00
General expenses, care of plant, etc., during last fiscal year						1,198.82		
		600,000.00		700,000.00		700,000.00		710,000.00

^a Not expended by Commission; assigned by Chief of Engineers for disbursement by engineer officer in charge of district above St. Louis City.

188 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

ALLOTTED BY CONGRESS.

For protection of 25 localities specially named.....	\$1,890,000
For protection of harbors and localities, river and harbor act 1888.....	203,000
For operating snag boat, river and harbor act February 22, 1890.....	\$75,000
For operating snag boat, river and harbor act 1899.....	85,000
	<u>110,000</u>
For repairs and contingencies, river and harbor act 1899.....	15,000
Total.....	2,218,000

In addition to the above, localities were named where work was to be done, but amounts not specified.

In some cases where amounts were specified for separate localities, they were reduced, under a discretion given to the Commission.

RECAPITULATION.

For systematic improvement:		
In vicinity of Kansas City, about 17 miles.....	\$670,501.96	
First Reach, about 45 miles.....	2,609,700.00	
		<u>\$3,280,201.96</u>
Miscellaneous work:		
For expenses of office and Commission.....	306,861.86	
For surveys, physical data, and publications.....	469,586.97	
For new plant and repairs of same.....	542,364.84	
For snagging operations, including amounts approved in acts of 1890 and 1899.....	380,082.27	
		<u>1,698,894.44</u>
For separate localities.....		2,164,364.25
General expenses, care of plant, etc., during last fiscal year.....		6,589.35
Total.....		<u>7,150,000.00</u>

Of the above amount \$240,000 was disbursed on account of work above Sioux City, while in charge of Commission, and is included in items of "Expenses of office and Commission," "Surveys, physical data, and publications," "New plant and repairs of same," and "Separate localities."

^aThere is included in this total a considerable sum which can not be definitely stated in this tabulation, probably amounting to at least \$500,000 during eighteen years, expended for movement and care of plant and for material not yet placed in work, charged to the allotments for systematic improvement.

Work.	Balances of appropriations July 1, 1901.					Sundry civil act of June 6, 1900.	Received by transfer from other allotments.	Refunded on account of over-payment.
	Act of Aug. 13, 1894.	Act of June 3, 1896.	Act of Jan. 5, 1899.	River and harbor act of Mar. 3, 1899.	Sundry civil act of Mar. 3, 1899.			
IMPROVING MISSOURI RIVER FROM MOUTH TO ST. LOUIS CITY, IOWA.							\$6,539.35	\$141.35
Office and traveling expenses and salaries of Commission.						\$5,967.05		
Surveys, gauges, physical data, and publications.						4,021.46		2.10
First reach						1,615.50		
Operating snag boat						1,972.73		
At Atchison, Kans.								
Pellou Bend above Kansas City, Mo.	\$1,195.82	\$890.99	\$3,022.42			3,153.21		
Local works above Kansas City, Mo.								
Repairs and contingencies.						\$0.81		
New plant.						37.92		
At Rulo, Nebr.						1,261.95		
Total	1,195.82	890.99	3,022.42		38.73	17,991.90	6,539.35	143.45
IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.								
Lock and dam (construction of lock, etc.)		14.06				9,703.87		
Snagging operations.		331.69						
Total		345.75				9,703.87		
IMPROVING GASCONADE RIVER.								
Removal of snags and other obstructions.				\$1,488.96				
Grand total	1,195.82	1,236.74	3,022.42	1,488.96	38.73	27,695.77	6,539.35	143.45

Financial statement from July 1, 1901, to June 30, 1902—Continued.

Work.	Total available.	Amount expended to May 31, 1902.	Expended during month of June, 1902.	Total amount expended to June 30, 1902.	Transferred to other allotments.	Total expended and transferred.	Total balances June 30, 1902.	Outstanding liabilities June 30, 1902.	Balance available June 30, 1902.
IMPROVING MISSOURI RIVER FROM MOUTH TO SIOUX CITY, IOWA.	\$6,680.70	\$5,082.23	\$1,504.18	\$6,586.41	.....	\$6,586.41	\$94.29	\$24.34	\$69.95
Office and traveling expenses and salaries of Commission.	5,969.15	4,530.51	.....	4,530.51	\$1,438.64	5,969.15	.....	.....	.....
Surveys, gauges, physical data, and publications.	4,021.46	2,082.43	.....	2,082.43	1,939.03	4,021.46	.....	.....	.....
First reach	1,615.50	1,615.50	.....	1,615.50	.....	1,615.50	.....	.....	.....
Operating snag boat.	1,972.73	630.00	.....	630.00	1,342.73	1,972.73	.....	.....	.....
At Atchison, Kans.	2,066.81	270.00	.....	270.00	1,816.81	2,066.81	.....	.....	.....
Pelican Bend and vicinity.	3,022.42	2,518.18	.....	2,518.18	.....	2,518.18	504.24	504.24	.....
Local works above Kansas City, Mo.	3,153.21	3,151.07	.....	3,151.07	2.14	3,153.21	.....	.....	.....
Repairs and contingencies	.....	81	.....	81	.....	81	.....	.....	.....
New plant.	37.82	37.82	.....	37.82	.....	37.82	.....	.....	.....
At Rulo, Nebr.	1,261.95	1,261.95	.....	1,261.95	.....	1,261.95	.....	.....	.....
Total	29,822.66	21,180.60	1,504.18	22,684.78	6,539.35	29,224.13	598.53	528.58	69.95
IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.									
Lock and dam (construction of lock, etc.)	9,717.93	3,540.09	585.46	4,125.55	.....	4,125.55	5,592.38	.....	5,592.38
Snagging operations.	331.69	.....	.....	.....	.....	.....	331.69	.....	331.69
Total	10,049.62	3,540.09	585.46	4,125.55	.....	4,125.55	5,924.07	.....	5,924.07
IMPROVING GASCONADE RIVER.									
Removal of snags and other obstructions	1,488.96	669.42	560.00	1,229.42	.....	1,229.42	259.54	.....	259.54
Grand total.	41,361.24	28,390.11	2,649.64	28,039.75	6,539.35	34,579.10	6,782.14	528.58	6,253.56

Detailed statement, July 5, 1884, to June 30, 1902.

Work.	Balance of appropriations of 1882.	Appropriations and allotments.	Refunded on account of overpayment, etc.	Total available.	Expended to May 31, 1902.	Expended during the month of June, 1902.	Total expended to June 30, 1902.	Total balances June 30, 1902.	Outstanding liabilities June 30, 1902.	Balance available June 30, 1902.
Survey of the Missouri River above the Missouri River Falls, Fort Benton, Mont.		\$15,000		\$15,000.00	\$15,000.00		\$15,000.00			
BETWEEN FORT BENTON, MONT., AND SIOUX CITY, IOWA.										
Office and inspection expenses of district officer	\$2,000.00	4,749.00		6,749.00	6,749.00		6,749.00			
Purchase and repair of plant	2,000.00	58,751.00		60,751.00	60,751.00		60,751.00			
Work below Fort Benton		31,500.00		31,500.00	31,500.00		31,500.00			
Improving Missouri River between Sioux City and Fort Benton		48,250.00	\$0.75	48,250.75	48,250.75		48,250.75			
Survey between Fort Benton and Sioux City		73,250.00	1.72	73,251.72	73,251.72		73,251.72			
Office expenses and expenses of Commission		5,000.00	53.24	5,053.24	5,053.24		5,053.24			
Expenses proper of Commission, gauges and physical data		3,500.00	20.02	3,520.02	3,520.02		3,520.02			
Total.	4,000.00	225,000.00	76.33	229,076.33	229,076.33		229,076.33			
Survey of Missouri River from its mouth to Fort Benton.	8,844.39			8,844.39	8,844.39		8,844.39			
BETWEEN SIOUX CITY, IOWA, AND THE MOUTH OF THE RIVER.										
Office and traveling expenses and salaries of Commission		6,539.35	141.35	6,680.70	5,082.23	\$1,504.18	6,586.41	\$94.29	\$24.34	\$69.95
Surveys, gauges, physical data, and publications		239,581.36	733.89	270,285.25	270,285.25		270,285.25			
Expenses proper of Commission, gauges and physical data		421,335.97	90.36	421,426.33	421,426.33		421,426.33			
Systematic improvement, first reach		33,800.00	188.97	33,988.97	33,988.97		33,988.97			
Operating snag boat (removal of snags, etc.)		2,602,087.16	272.62	2,602,359.78	2,602,359.78		2,602,359.78			
Construction, repair, and care of plant	1,982.30	380,082.27	19.40	382,084.47	382,084.47		382,084.47			
Repairs to works and contingencies		458,864.84	12.75	458,877.59	458,877.59		458,877.59			
Omaha, Nebr., and Council Bluffs, Iowa.		84,500.00	.82	84,500.82	84,500.82		84,500.82			
Nebraska City and Nebraska City Island, Nebr.		404,541.64	5.00	404,546.64	404,541.64		404,541.64			
Rulo, Nebr.		67,788.92		67,788.92	67,788.92		67,788.92			
St. Joseph, Mo., and vicinity		104,592.37		104,592.37	104,592.37		104,592.37			
Atchison, Kans.		629,769.98	14.87	629,784.85	629,784.85		629,784.85			
Leavenworth, Kans.		94,822.33		94,822.33	94,822.33		94,822.33			
Kansas City, Mo., and vicinity		113,713.71		113,713.71	113,713.71		113,713.71			
Sioux City, Iowa.		673,574.54	72.58	673,574.54	673,574.54		673,574.54			
Atrow Rock, Mo.		80,411.67		80,411.67	80,411.67		80,411.67			
Miami, Mo.		36,284.98		36,284.98	36,284.98		36,284.98			
Total.		19,787.67		19,787.67	19,787.67		19,787.67			

Detailed statement, July 5, 1884, to June 30, 1902—Continued.

Work.	Balance of appropriations of 1882.	Appropriations and allotments.	Refunded on account of overpayment, etc.	Total available.	Expended to May 31, 1902.	Expended during the month of June, 1902.	Total expended to June 30, 1902.	Total balances June 30, 1902.	Outstanding liabilities June 30, 1902.	Balance available June 30, 1902.
Local works above Kansas City, Mo.		\$84,178.58		\$84,178.58	\$84,178.58		\$84,178.58			
Local works below Kansas City, Mo.		445,612.84	\$0.80	445,613.64	445,109.40		445,109.40	\$504.24	\$504.24	
Total.	\$1,982.30	6,911,792.60	1,553.41	6,915,328.81	6,913,226.10	\$1,504.18	6,914,730.28	598.53	628.58	\$69.95
IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.										
Lock and dam (construction of lock, etc.)		342,855.18	10.69	342,865.87	336,688.03	585.46	337,273.49	5,592.38		5,592.38
Snagging operations		9,366.44		9,366.44	9,084.75		9,084.75	381.69		381.69
Examination of the stream		800.00		800.00	800.00		800.00			
Total.		353,021.62	10.69	353,032.31	346,572.78	585.46	347,158.24	5,924.07		5,924.07
IMPROVING GASCONADE RIVER, MISSOURI.										
Removal of snags and other obstructions.		24,638.11		24,638.11	23,818.57	560.00	24,378.57	259.54		259.54
Examination of the stream from mouth to Arlington.		500.00		500.00	500.00		500.00			
Total.		25,138.11		25,138.11	24,318.57	560.00	24,878.57	259.54		259.54
Grand total.	14,827.19	7,529,962.33	1,640.43	7,546,419.95	7,536,988.17	2,649.64	7,539,637.81	6,782.14	528.08	6,258.56

MISSOURI RIVER COMMISSION.

193

Consolidated statement, July 5, 1884, to June 30, 1902.

Improving Missouri River from mouth to Sioux City, Iowa:

Act of July 5, 1884	\$840,000.00
Act of August 5, 1886	375,000.00
Act of August 11, 1888	1,000,000.00
Act of February 22, 1890	75,000.00
Act of September 19, 1890	800,000.00
Act of July 13, 1892	600,000.00
Act of March 3, 1893	700,000.00
Act of August 18, 1894	700,000.00
Act of March 2, 1895	710,000.00
Act of June 3, 1896	300,000.00
Act of June 4, 1897	300,000.00
Act of July 1, 1898	300,000.00
Act of January 5, 1899	100,000.00
Act of March 3, 1899 (river and harbor)	100,000.00
Act of March 3, 1899 (sundry civil)	200,000.00
Act of June 6, 1900 (sundry civil)	250,000.00

Total specific appropriations\$7,150,000.00

Balance from former appropriations—

Act of August 2, 1882, applied to works above Sioux City, Iowa	4,000.00
Survey of Missouri River from mouth to Fort Ben- ton	8,844.39
Act of August 5, 1886, applied to removing ob- structions from Missouri River	1,982.80

Total balances14,827.19

Refunded on account of overpayment, etc3,422.34

Total7,168,249.53

Improving Osage River, Missouri and Kansas:

Act of August 18, 1894	\$46,000.00
Act of June 3, 1896	50,000.00
Act of March 3, 1899	25,000.00
Act of June 6, 1900	146,000.00
Balances transferred January 15, 1895, from Maj. Charles J. Allen, Corps of Engineers—	
Act of September 19, 1890	42,655.18
Act of July 13, 1892	43,366.44
Refunded on account of overpayment	10.69

Total353,032.31

Improving Gasconade River, Missouri:

Act of August 18, 1894	5,000.00
Act of June 3, 1896	5,000.00
Act of March 3, 1899	15,000.00
Balance transferred January 15, 1895, from Maj. Charles J. Allen, Corps of Engineers, act of July 13, 1892	138.11

Total25,138.11

Grand total7,546,419.95

Expended to June 30, 1902:

For improving Missouri River	7,167,651.00
For improving Osage River	347,108.24
For improving Gasconade River	24,878.57

Total7,539,637.81

Balance June 30, 19026,782.14

Sup. Eng.—02—13

194 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

LIST OF APPENDICES ACCOMPANYING THIS REPORT.

- A. Brief description of works built under the direction of the Missouri River Commission since its creation July 5, 1884, with maps of the localities.
- B. Reports on commercial statistics, by A. H. Blaisdell, assistant engineer.
- C. Report on water gauges, by A. H. Blaisdell, assistant engineer.
- D. Report on Missouri River, by S. Waters Fox, assistant engineer.
- E. Report on Osage River, Missouri, by S. Waters Fox, assistant engineer.
- F. Report on Gasconade River, Missouri, by S. Waters Fox, assistant engineer.

APPENDIX A.

BRIEF DESCRIPTION OF WORKS BUILT UNDER THE DIRECTION OF THE MISSOURI RIVER COMMISSION SINCE ITS CREATION JULY 5, 1884.

SIoux CITY, IOWA (807 MILES ABOVE MOUTH).

The works of improvement at Sioux City were in charge of the Missouri River Commission until the appropriation acts of August, 1894, in which the jurisdiction of the Commission was defined as extending from the mouth to the "lower limits of Sioux City, Iowa."

In the act of August 11, 1888, Congress made a specific allotment of \$100,000 from the general appropriation to be expended at Sioux City, of which the Commission allotted \$80,496.12 for operations in the field.

The work was projected to protect from erosion the bottom lands constituting a large portion of the city's water front, and to extend the shore line out to a desired line of rectification alike advantageous to the city and the control of the flow.

Nine permeable dikes were built during 1889, spaced at intervals of about 500 feet, on lines nearly normal to the shore; their aggregate length was 4,250 feet, the longest being about 680 feet. These dikes have proved entirely successful in accomplishing the purposes for which they were designed. They have received a small amount of repairs since their construction, and the new bank they have formed could readily be made permanent by revetment.

For details concerning these works, see annual reports of the Chief of Engineers, United States Army, for 1889-1891.

OMAHA, NEBR., AND COUNCIL BLUFFS, IOWA (667 MILES ABOVE MOUTH).

The following table is an exhibit of the allotments and expenditures made in this vicinity under the several appropriation acts:

Date of appropriation acts.	Allotments from general appropriations made by Congress.	Distribution for field operations made by Missouri River Commission.
August 11, 1888.....	\$150,000.00	\$120,994.19
September 19, 1890.....		82,000.00
July 13, 1892.....		30,000.00
March 3, 1893.....		16,800.00
August 18, 1894.....	75,000.00	75,000.00
June 3, 1896.....	70,000.00	40,000.00
March 3, 1899.....	50,000.00	40,000.00
Total.....	345,000.00	404,794.19

It will be noticed that the amount expended by the Commission exceeded the special allotments made by Congress by nearly \$60,000; this additional sum was used for the extension of the work constructed under the first allotment and became necessary for the preservation of the earlier work and further control of the flow.

The work performed under the first allotment consisted in protecting by revetment 13,000 linear feet of the left bank of the river, the head of the work being about 6 miles above Omaha. Under the allotments of 1892 and 1893, the revetment was extended 12,260 linear feet down stream.

Near the foot of the first work, and before the revetment had reached it, a deep pocket had been washed into the unprotected bank, in which eddy action was so violent that the ordinary revetment failed to protect it, and it became necessary to

mask this pocket and even out the curve of the bank by a longitudinal and seven spur dikes, aggregating 6,400 feet in length. These dikes were completed in 1897, up to which date there had also been placed 2,685 linear feet of renewed revetment, and 1,600 linear feet of upper bank repair.

During the seasons of 1900 and 1901 there were built for the protection of the left bank and rectification of flow 700 linear feet of bank revetment and two dikes, aggregating 800 linear feet, at a much exposed point near Pigeon Creek, 13 miles above Omaha, and also 1,884 linear feet of bank revetment on the right bank, near Florence Lake, 8 miles above Omaha, where rapid erosion of bank was in progress and had developed a shore line which it became important to hold, as further erosion would so change the flow as to endanger the safety of the lower works and incidentally the approach to the Council Bluffs and East Omaha bridge.

The revetment of 1889 and 1890 proved efficient until the high water of July, 1898, when, from flanking at the head, about 2,700 feet of it was washed out; the bank thus exposed was covered by the railroad company, whose roadbed it protected. Another break of about 1,600 feet, at the foot of the first break, occurred during the spring flood of 1899; this break was also covered by the railroad company.

With the exception of slight injury to the stream ends of the dikes at Pigeon Creek, no damages to the works at Omaha and Council Bluffs have occurred.

For details of these works, see Annual Reports of the Chief of Engineers United States Army, for 1890, 1892-1897, 1900-1901.

NEBRASKA CITY, NEBR. (610 MILES ABOVE MOUTH).

The work at Nebraska City from 1889 to 1897 was carried on under specific allotments of \$100,000 made by Congress from the general appropriation for the Missouri River, of which the Commission distributed \$67,747.10 for operations in the field, and during the years 1898 to 1901 from a proportion of the general allotment of \$82,000 for "Local works above Kansas City" made by the Commission from the appropriations of 1897, 1899, and 1900.

The work since 1897 was principally in the direction of a rectification of the channel in order to prevent the flanking and destruction of the earlier revetment work.

During the fiscal years 1890 and 1891, 5,750 linear feet of bank on the Iowa side of the river above the railroad bridge was revetted.

In 1897 three short dikes were placed at the head of this revetment to prevent a threatened flanking, and from 1898 to 1901 two dikes with curved ends, and later a longitudinal dike, were built having in view the diversion of the channel toward the Nebraska side.

Much difficulty was experienced in holding the first dikes against the current and heavy flows of drift; breaches in the structures occurred necessitating heavy repairs, but since the building of the longitudinal dike the conditions of flow have much improved.

On the Nebraska shore some stone revetment work was placed, aggregating 486 linear feet.

For detailed description of these works, see Annual Reports of the Chief of Engineers United States Army, for 1890, 1891, 1897-1901.

RULO, NEBR. (538 MILES ABOVE MOUTH).

The work has consisted solely in the protection by revetment of the left bank in Rush Bottom Bend, about 3½ miles above the Chicago, Burlington and Quincy Railroad bridge at Rulo.

Under a specific allotment of \$50,000 in the act of August 11, 1888, made by Congress from the general appropriation for the river, the bank at the head of the bend was revetted for a distance of 4,922 linear feet.

No further funds were made available for this work until in the sundry civil act of June 6, 1900, the Commission was directed to prevent a threatened damage near Rulo.

At this time the first revetment had been entirely destroyed by flanking, and the bank, which it had protected, had receded from 500 to 1,400 feet.

A standard bank revetment 5,280 feet in length was placed in the head of the bend. A total of the expenditures for the Rulo work is \$104,998.06. During the years 1900, 1901, and 1902 the Chicago, Burlington and Quincy Railway Company has extended the revetment 10,370 linear feet downstream, of which 7,975 linear feet were built during the last fiscal year, and of the latter 6,035 linear feet conformed to the standard specifications used by the Missouri River Commission.

For details of the work see Annual Reports of the Chief of Engineers United States Army, for 1890, 1891, 1901, 1902.

ST. JOSEPH, MO. (479 MILES ABOVE MOUTH).

Previous to the creation of the Missouri River Commission a cut-off of the Kansas point opposite St. Joseph was threatened, to prevent which over 3 miles of revetment had been placed and other works built costing over \$100,000.

The Commission, in order to save this work and also to preserve the favorable regimen of river then existing, found it necessary to largely exceed in their expenditures the specific allotments which Congress had made for St. Joseph and vicinity.

The Congressional allotments in which St. Joseph is specifically named amounted to \$175,000, and the expenditures of the Commission have been \$533,569.98, which sum is to be further increased by a proportion of about \$81,000 allotted by the Commission for Local Works above Kansas City from the appropriation of 1897, 1899, and 1900.

St. Joseph is situated at the lower apex of a deep S-shaped series of bends, the bends above being designated as Elwood, Belmont, and Bon Ton, and until 1899 all the work had been directed to the protection of the caving banks of these bends.

In Elwood and Belmont bends, which are practically one, the Kansas bank was revetted for a distance of about 19,500 feet, and in Bon Ton bend the Missouri bank for a distance of 19,332 feet, a total of over 7.3 miles.

These revetments have received a large amount of repair work and renewals, and at the present time stand in need of a considerable amount of repair, but they have been and are effective in preventing a cut-off in the river which would have been attended with disastrous results to the interests of St. Joseph, and had a far-reaching and detrimental effect on navigation.

In 1899 and 1900 a rapid caving of the Missouri bank had developed in the bend below St. Joseph, and 2,659 linear feet of revetment was placed as protection; the foot of the revetment was terminated by a longitudinal dike 330 feet in length designed to divert the flow from the lower part of the bend. This later work was limited in extent by the small amount of money available, but is effective in largely diminishing the erosion in the bend.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1885-1896, 1899-1901.

ATCHISON, KANS. (448 MILES ABOVE MOUTH).

The specific allotments made by Congress from the general appropriations for the vicinity of Atchison have amounted to \$125,000, and the distribution made by the Commission for operations in the field was \$94,430.28. The work was entirely confined to the protection of the left bank within a distance of 2 miles above the Atchison bridge and the securing of a navigable channel through the draw opening of the bridge. In 1887 the erosion of the bank had extended until there was imminent danger of the loss of the eastern approach of the bridge and the main channel passing under one of the fixed spans rendered the bridge the practicable head of navigation.

In 1887 and 1888 the local railroad interests and the bridge company built as bank protection 3,500 linear feet of revetment, 4 training dikes, and 19 short stone dikes.

In the fall of 1888, the Commission, in their work of channel rectification utilized as far as possible the previous work and built 3,564 linear feet of pile dikes and 1,954 linear feet of revetment. These works were effective in directing the channel into the draw openings of the bridge and in protecting the bank until in June, 1891, when a cut-off occurring in the bends immediately above, the entire regimen of the river became changed.

A deep bend began forming in the left bank above the pile dikes and the works were gradually washed away and the railroad approaches from the north were destroyed.

During 1894 the railroad and bridge companies did considerable work to prevent further erosion, and in 1895 the bridge company proffered the Commission, without cost, brush and stone for a revetment of the bank. Under this arrangement 6,300 linear feet of bank was revetted and 300 linear feet of mattress heading built, the principal cost to the Commission being for labor and superintendence.

A short time after the completion of this work, during the subsidence of high water, the river partially took a course into an experimental ditch which had been cut, with that end in view, by the bridge company, through an old chute of Atchison Island, situated well over toward the Kansas shore. This channel gradually enlarged until it became the main channel of the river.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1889-1892, 1895, 1896.

FORT LEAVENWORTH AND LEAVENWORTH, KANS. (423 MILES ABOVE MOUTH).

The works of the Commission in this vicinity extended from the low draw bridge at Leavenworth to a point about 3.7 miles above the high bridge at Fort Leavenworth, a total distance of 6 miles.

The specific allotments from the general appropriation made by Congress amounted to \$95,000, and the allotments made by the Commission aggregated \$107,747.09.

The first work undertaken was under the Congressional allotment of \$75,000 from the act of August 11, 1888, and consisted of the revetment of 6,658 linear feet of the left bank in Bee Creek Bend, about 3 miles above Fort Leavenworth Bridge.

The cutting bank, thus protected, was threatening the destruction of the railroad approach to Fort Leavenworth Bridge and unless arrested would ultimately endanger the bridge itself.

The next work, in 1895 and 1896, consisted in the placing of two pile dikes, aggregating 2,040 feet in length, about halfway between the two bridges, with the object of closing a left-hand channel of the river which was endangering the safety of the east railroad approach to the Leavenworth bridge, and also to direct the main channel into the draw opening of the bridge.

In 1897 the bank on the Missouri side above the Fort Leavenworth Bridge was cutting rapidly lower down in the bend, causing a change in channel direction and leaving a large sand bar in front of the landing at Fort Leavenworth, and three dikes, aggregating 600 feet in length, were placed to check the caving and divert the channel.

In 1899 a dike 350 feet in length and 270 linear feet of inshore screen work were placed on the left bank a short distance above the Leavenworth Bridge to prevent erosion, during high water, along some work placed by the bridge company to protect their eastern approach and to correct the flow.

The works placed by the Commission have been injured to some extent by the ice and by scour, but they have all been effective in producing the results for which they were designed.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1890, 1895, 1896, 1898, 1899, 1900.

KANSAS CITY AND VICINITY, MISSOURI AND KANSAS (391 MILES ABOVE MOUTH).

The works in the vicinity of Kansas City extended from a point about 3.8 miles below the Hannibal and St. Joseph Railroad bridge for a distance of more than 17 miles up stream, embracing bank revetment and dike work in East Bottom Bend and Harlem Front, bank revetment in Kaw and Quindaro bends, and revetment and dike work in Little Platte Bend. Two small dikes were also placed in the mouth of Kansas River with the object of contracting the width and increasing the velocity of flow.

Before the creation of the Commission, in 1884, a considerable amount of work had been in progress, continuously since 1879, in the locality, and the Commission, in order to utilize the work already placed, selected Kansas City as the initial point in their plans for a systematic improvement of the river for navigation purposes.

In the act of September 19, 1890, Congress directed the Commission to expend subsequent appropriations in the systematic improvement of the river in reaches from the mouth up, and the later work in the vicinity of Kansas City was directed to the extension and completion of the works already placed and for their preservation.

After 1893 no work was performed until 1898-99, when the dikes in the mouth of Kansas River were built under a specific allotment by Congress, and some repairs were made to East Bottom revetment.

The specific allotments made by Congress for the Kansas City work amounts to \$90,000, and the allotments made by the Commission aggregate \$670,501.96.

In detail the work consisted of:

	Linear feet.
Bank revetment built in—	
East Bottom Bend and Harlem Front.....	14,466
Kaw Bend.....	12,612
Quindaro Bend.....	9,760
Little Platte Bend.....	7,770
Dikes built—	
At Kansas City and Harlem.....	8,416
In Little Platte Bend.....	2,056
In mouth of Kansas River.....	300

A total of 44,608 linear feet of revetment and 10,772 linear feet of dike.

198 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

At the time of the last inspection, in 1900, the most serious damage to the works had occurred in Little Platte Bend, where the entire dike work and about three-sevenths of the revetment had been destroyed by flanking.

Much of the Kansas City and Harlem dike work has been destroyed, but that on the Kansas City side has been very effective in building up large accretions, some of which extend to the established harbor line.

The older revetments have received a considerable amount of repair and renewals, and there are now a number of detached breaks in them which should be restored, but their general integrity has not been destroyed, and through them vast local interests have been preserved and a fairly satisfactory condition of navigation has been maintained.

For details see Annual Reports of the Chief of Engineers United States Army, for 1885-1893, 1899-1900.

RANDOLPH BEND, MO. (368 MILES ABOVE MOUTH).

In the spring of 1900, under a specific allotment of \$15,000 made by Congress from the general appropriation act of March 3, 1899, the bank in front of the town of Randolph, Mo., was covered by revetment for a distance of 1,200 linear feet.

The allotment made by the Commission for the work was \$12,000.

The work is so small in extent that although it is in good condition at present, as far as known, its loss through flanking at the head will probably occur unless it be extended at an early date both upstream and downstream beyond the limits of caving bank.

For details see Annual Report of the Chief of Engineers United States Army, for 1900.

NEAR MOUTH OF LITTLE BLUE, MISSOURI (368 MILES ABOVE MOUTH).

The work in this locality was inaugurated under an allotment made by Congress in the river and harbor act of June 3, 1896.

The total allotments specifically made by Congress since that date amounted to \$35,000 and those made by the Commission directly to the locality aggregate \$25,000, which sum was largely increased by suballotment from the general allotment for Local Works below Kansas City. The work was carried on from 1897 to 1900, inclusive.

The project had for its object the closing of two shore channels, one on each side of the river, formed by islands, the direction of the flow into a more favorable channel for navigation, and the further direction and holding of the rectified channel below by accessory works on the bank.

The closing of the right-shore channel behind Blue Mills Island, which was a narrow but a deep one, was successfully accomplished by a permeable pile dike 420 feet in length.

A dike on the left shore, which was designed to produce a fill in the island chute and also to divert the channel, was twice breached and twice flanked. After its repair in 1900 its total length was 1,712 feet. It was subjected to severe attacks during high stages, and was again breached during the high water of 1901.

The other works consisted of 876 linear feet of bank revetment in two locations, two short dikes of a combined length of 231 feet, and a special structure, which has been called a bank head, designed not only to protect the bank, but also to have a directive influence on the course of the channel. All of these accessory works were built on the right bank of the river.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1898-1901.

LEXINGTON, MO. (322 MILES ABOVE MOUTH).

The only work placed by the Commission in this locality was under a specific allotment of \$10,000 made by Congress in the act of March 3, 1899. It consisted of the building of four pile dikes on the left bank opposite the town, having an aggregate length of 647 feet, with a view of causing and maintaining a higher crossing to the bluffs on the Lexington side and incidentally of protecting the river terminus of the Atchison, Topeka and Santa Fe Railroad.

An examination made in June, 1900, showed that one of the dikes had been damaged by ice and drift, and doubtless the damage has increased since then.

For details of these works see Annual Report of the Chief of Engineers United States Army, for 1900.

MIAMI, MO. (271 MILES ABOVE MOUTH).

The first work undertaken at this locality was under a special allotment of \$25,000 made by Congress from the general appropriation carried by the act of August 11, 1888.

Three pile dikes were built on the right bank, about 1 mile below town, having an aggregate length of 1,302 feet, to check erosion and deflect the channel from a pocket formed in the bank.

No further funds were provided for the locality until, under the act of June 3, 1896, Congress made a specific allotment of \$65,000 from the general appropriation.

The three dikes had proved effective in fairing out the shore line as desired, but in the lapse of time their ends and the newly formed bank had gradually worn away until there were but a few benches of the dikes at their shore ends remaining.

The new work, commenced in 1897, consisted in building a pile dike 1,800 feet in length from the left bank to close an unfavorable chute in the wide and unstable river and the construction of a bank head further down the river, in the right bank, to protect that bank and to direct the flow into a favorable crossing to the bluffs at Dewitt, about 4 miles below.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1890, 1898-1900.

ABOVE GLASGOW, MO. (247 MILES ABOVE MOUTH).

The work carried on by the Commission in this locality was nearly all centralized in Wilhoite Bend, about 9½ miles above the city of Glasgow, Mo.

The allotments specifically made by Congress since 1896 aggregate \$105,000; the Commission allotted directly for the work the sum of \$33,000 and largely supplemented it by suballotment from the general allotment for "Local works below Kansas City."

Here was inaugurated a new system of bank protection and river control, to which the name of bank-head system has been given. It consists essentially in revetting very heavily short lengths of bank in a conical form, spaced at such intervals that there can be no great amount of caving between them.

The caving of the bank was expected to continue until a certain degree of curvature had been attained, when the resistances to the flow around the bend would become greater than the resistances on a line farther out in the stream.

The distances apart that these bank heads should be placed was to a considerable extent experimental, being dependent on the conditions of flow and character of bank, which vary with every locality.

In a distance of 8,000 feet in Wilhoite Bend three bank heads were built, and also a single one some 18,000 feet up the river in Little Missouri Bend, designed to preserve as far as was possible with the means at hand the existing conditions of flow in the upper end of the lower bend.

The work in Wilhoite Bend was prosecuted each season as funds became available from 1897 to 1900, inclusive.

Changes in direction of local flow approach necessitated a considerable extension and reenforcement of the bank heads, and some dike and abattis work were built on the opposite side of the river with a view of channel correction.

The anticipated results from the bank heads were not obtained until 1900, when a very satisfactory foreshore formed in the bend between the bank heads. As an aid to the extension and the security of the foreshore a T dike, having suspended mattresses, was built between the two lower bank heads where the exposure was greatest.

Some repair and reenforcement were also done on the revetment of the right bank in the upper end of Cambridge Bend, below Wilhoite, which was built in 1889 by the Chicago and Alton Railway Company.

At the last examination made of the vicinity the works in Wilhoite Bend appear to have been effective in producing the conditions of flow desired; the banks have apparently reached a condition of stability and the works have received but little damage.

For details of these works see Annual Reports of the Chief of Engineers United States Army, for 1898-1902.

ARROW ROCK, MISSOURI, OR NIGGER BEND (224 MILES ABOVE MOUTH).

The work in this locality consisted of the protection by revetment of the left bank of the river above Arrow Rock, in Nigger Bend, and was carried on under specific allotments of \$45,000 and \$10,000 made by Congress from the general appropriation in the acts of August 11, 1888, and March 3, 1899, respectively.

250 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

In 1899 3,935 linear feet of bank revetment was placed near the head of the bend and in 1899 a downstream extension of 738 linear feet was made to the old revetment. A little more than one-third of the cutting bank in the bend is protected.

The revetment work is at present in good condition.

For details of the work see Annual Reports of the Chief of Engineers United States Army, for 1890 and 1900.

ROCHEPORT, MO. (196 MILES ABOVE MOUTH).

To this locality the sum of \$50,000 was specifically allotted by Congress from the general appropriation carried by the act of June 3, 1896.

The work of the Commission was carried on under the general allotment made by them for Local Works below Kansas City.

The improvement consisted of a bankhead built on the right bank about 2 miles above Rocheport, designed to hold the channel as it then existed in a direction against the bluff line above Rocheport.

The bankhead was built in 1898 and received repairs and extensions in 1899 and 1900.

The desired channel crossing has been maintained, but the single bankhead has been subjected to severe attack and is in urgent need of repair and reinforcement.

For details of the work see Annual Reports of the Chief of Engineers United States Army, 1898-1901.

HUNTSDALE, MO. (188 MILES ABOVE MOUTH).

At this point the river was cutting into the cultivated bank above and below the town and the works placed by the Commission were designed principally for protective purposes.

Two allotments of \$10,000 each were specifically made by Congress from the general appropriation acts of 1898 and 1899 for the work.

To induce deposits in the bend a device having the general form of an abattis, placed in a reversed position to the flow of the current, was constructed during the low water of December, 1898, in two rows having an aggregate length of 688 feet across the low bar and in the shallow water in the bend.

These structures proved very effective; a high shore bar was formed extending about 2,600 feet below and a much greater distance above.

In March, 1900, the bank immediately below the lower accretions began to cut, and 825 linear feet of it was covered by revetment.

For details of the works see Annual Reports of the Chief of Engineers, United States Army, for 1899 and 1900.

FIRST REACH.

The portion of the river covered by this designation extends from the mouth to the head of Murrays Bend, about 5 miles above Jefferson City, Mo., a total distance of about 156 miles.

Previous to the creation of the Missouri River Commission, appropriations had been made in totally inadequate amounts for improvement at thirteen different localities on the river between its mouth and Sioux City, and until the act of September 19, 1890, the same course in respect to diversion of funds had been pursued during the six years the river had been placed in charge of the Commission.

Under the act of 1890, however, Congress directed that, with certain specified exceptions, the appropriations be expended by the Secretary of War "in the systematic improvement of the river from its mouth up, according to the plans and specifications of the Missouri River Commission, to be approved by him, in reaches to be designated by them."

Under the succeeding liberal appropriations made in the acts of 1892, 1893, 1894, and 1895 and the continuous contract system a large amount of work was performed over about 45 miles of river at the head of the first reach. This portion of the river embraced the mouths of the Osage and Gasconade tributaries, which bring large quantities of gravel into the parent stream, and that and other reasons rendered rectification more difficult here than would ordinarily obtain at other localities.

The work proved very successful. On bars and crossings, where formerly existed only 30 inches of water or less, 6 feet or more were obtained and the former tortuous and changeable channel was replaced by one of easy curvature and measurable stability.

Lines of desired rectification were laid down and by the building of permeable pile

dikes large accretions were formed bounding the waterway on one side, the river being trained against the bluffs on the other side wherever practicable, or if the conditions compelled the directing of the current against a friable bank the bank received a revetment of brush and stone.

From the very nature of the material used in the construction of the dikes—wooden piles—it could not be expected that they alone could maintain the permanency of the soft yielding bank formed by accretion; when such a bank had obtained its desired extent and proper height, it would also at places require protection by revetment. The revetment itself, although more permanent than the dikes, requires, like any other structure, occasional repair for its maintenance, prompt and slight repair at the first sign of failure often saving large amounts in renewals due to neglect.

Beginning, however, with the appropriation of \$300,000, carried by the act of 1896, under the continuing contract system and all subsequent appropriations, there was such a large diversion of funds to localities at detached places, extending from Pelican Bend to Omaha, 660 miles, that there remained but a very small amount to continue the systematic work on the first reach and scarcely any to devote to the repair and preservation of what had already been placed.

Some of the most important work on the reach undertaken subsequent to 1895 were the cut for a new outlet of the Osage River, through Osage Point, bringing that river into the Missouri above Dodds Island. This was rendered necessary, together with a change in the rectification lines, on account of the difficulty of holding a dam which had been built across the old high-water chute of the river, and also of a series of dikes lower down, all of which had failed on account of the hydraulic head they were subjected to when either river was at a higher comparative stage than the other, it being deemed by the Commission more economical to make the cut and change the existing rectification lines than it would to rebuild and hold the dam and dikes.

That the contemplated change in outlet of the Osage River has not taken place is due to the lack of funds to complete the project.

In Chamois Bend an experimental structure, which has been designated a bank-head, was built for the protection of the caving bank and regulation of the line of flow, and also with a view of adopting this type of improvement work at other localities as a substitute for the expensive system of bank revetment. This was the first work of its kind, and the success which resulted from its construction led to its adoption for the improvement at the other localities mentioned in this report.

At Jefferson City, under a specific allotment made by Congress in the act of 1899, a considerable amount of dike and abattis work was placed, the object being to restore the original approved line of rectification opposite the city, which had been changed through changed conditions in the river above and the building of the railroad bridge. The desired results were effected by the works.

The total amount of permeable pile dikes built in the 45 miles at the head of the First Reach aggregate about 107,056 linear feet, exclusive of renewals or repairs. These dikes varied in width of row from 1 to 5 piles, but the three-row work largely predominated.

As closely as can be estimated in the absence of extensive and costly survey, about 6,000 linear feet of the dikes, or less than 6 per cent of the whole, have been destroyed, and this loss was due almost wholly to lack of funds for repair work.

Much the greater number of these dikes have produced accretions, many acres of which are now cultivated and are as lasting as the older banks of the river, and this portion of the river, although much renewal work should be done, will continue to be the best instead of the worse portion, as it was before the improvements were commenced.

On the 45 miles of river, 58,391 linear feet of bank were protected by revetment, and all of this, except about 425 linear feet at the extreme head of the reach (Murray's Bend), has proven effective and is in good condition. There are doubtless some portions of it which should receive repairs, but none of it except that mentioned of an expensive nature.

The amounts expended on the 45 miles of systematically improved river aggregate about \$2,609,700, which amount includes a very considerable expenditure for movement and care of plant and for material not yet placed in the work. It should not be considered that the rectification of other portions of the river would cost proportionately.

The Commission desires to emphasize the fact that over no other part of the river will equal difficulties be encountered, and that through the experience gained a large decrease in cost of rectification can be confidently expected.

For details of the works on the First Reach, see Annual Reports of the Chief of Engineers United States Army, for 1892-1901.

202 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

HOWARDS BEND, ABOVE ST. CHARLES, MO. (36 MILES ABOVE MOUTH).

The improvement work in this locality was carried on under a specific allotment of \$50,000 made by Congress from the general appropriation in the act of June 3, 1896.

The work in Howards Bend was of the same nature as that in Wilhoite Bend, above Glasgow, consisting of three bank heads with a short longitudinal and stem dike placed between the two lower ones when it became evident the space between the lower bank heads, about 5,450 feet, was too great.

The effects of the structures has not yet been so evident in forming a wide foreshore along the former caving bank as in Wilhoite Bend, but the works have been effective in protecting the bank, changing the direction of flow, and improving the steamboat channel.

For details of the work, see Annual Reports of the Chief of Engineers United States Army, for 1898-1901.

PELICAN BEND, MO. (15 MILES ABOVE MOUTH).

The improvement work in Pelican Bend, consisting solely of bank revetment, was carried on under a specific allotment of \$50,000 made by Congress from the general appropriation act of July 1, 1898, and also from a specific allotment of \$100,000 made in the urgent deficiency act of January 5, 1899, from the general appropriation act of March 3, 1899.

A deep bend in the left bank of the river, along which run the tracks of the Chicago, Burlington and Quincy Railway and the Missouri, Kansas and Texas Railway, was covered with the standard type of continuous revetment for a length of 15,198 linear feet.

For details of the work, see Annual Reports of the Chief of Engineers United States Army, for 1899 and 1900.

SURVEYS AND PUBLICATIONS.

In addition to the many local surveys executed at localities where improvement work has been carried on, or where projects and estimates with a view to improvement have been asked for by Congress, the Commission in 1891 completed a secondary triangulation from St. Louis, Mo., connecting with the similar work of the Mississippi River Commission and the United States and Geodetic Survey to Three Forks, Mont., near the junction of the Gallatin, Jefferson, and Madison rivers, which unite to form the Missouri.

The axial distance covered by this network of triangles is 1,840 miles, while the river distance covered is 2,568 miles.

Under the provisions of the river and harbor act of September 19, 1890, the river above Sioux City, Iowa, had been made an independent district, and the shore line and topographical surveys of that portion of the river were principally done under the direction of the Engineer officers in charge of the district, with the following exceptions which were made by the Commission: Three Forks to Stubbs Ferry, 87 miles, and Wolf Point to Sun River, 445 miles.

With a view of having an accurate map of the river below Sioux City, based on the triangulation work, as speedily as possible, a rapid shore-line survey with sketched topography was made from Sioux City to the mouth, 810 miles. The Commission prepared large scale working maps from these surveys on which to base projects for improvement and for the study of river phenomena.

A set of reduced maps on a scale of one inch to one mile were also prepared for publication, embracing not only those from surveys conducted by the Commission, but also those made under the direction of the Engineer officers in charge of the upper river district, and a continuous map of the river from the mouth of Three Forks was thus completed. The publication of this series of maps was completed in 1895, an edition of 1,000 having been printed by the photolithographic process. The full set is comprised in 96 sheets and is available for distribution to those interested in the river at a small cost to cover expense of paper and publication.

The shore-line surveys, covering, as they did, only the immediate bank of the river, were intended only as preliminary to a topographical survey of the entire valley of the Missouri, on the maps of which could be delineated all the physical features of the country, and projects for complete rectification of the river could be studied.

Such surveys were carried on under small allotments made by the Commission from 1894 to 1898, and have been completed and mapped from the mouth of the river for a distance of 400 miles, or about 10 miles above Kansas City, Mo.

An important local survey, performed under the direction of the Commission, was the establishment of a harbor line at Kansas City, Mo. and Kans., which, by the direction of the Secretary of War, was undertaken in 1893.

In connection with the general surveys, level lines have been run and permanent bench marks established.

The levels between the mouth and Sioux City were levels of precision, and those of the upper river ordinary checked wye levels.

The permanent bench marks were established on lines crossing and about normal to the river from 3 to 5 miles apart.

Water gauges sufficient in number for study of stages were maintained by the Commission up to March, 1901, when the failure of the river and harbor bill in Congress compelled their discontinuance.

Observations for discharge and sediment have also been made in considerable number for the study of physical characteristics of the river.

For details of the survey work, see Annual Reports of the Chief of Engineers United States Army, for 1885-1899.

REMOVAL OF OBSTRUCTIONS.

The Commission has had under its direction the operations of one snag boat, dating from March, 1889, when a boat originally designed for the Missouri River was completed and received her equipment.

An aggregate of her work was the destroying of 17,676 snags, removing 69 drift piles, cutting 6,076 trees liable to become snags, and running 28,108 miles.

The total amount expended in the operations of the boat, including cost of completing the boat after she was turned over to the Commission in 1888, repairs, etc., was \$380,082.27, of which \$110,000 was specifically allotted by Congress.

OSAGE RIVER.

This river was placed under the jurisdiction of the Missouri River Commission by a provision of the river and harbor act of August 17, 1894.

The work previously done on the river consisted in open-river improvement by building low dikes and training walls on the shoals, and removing snags, leaning timber, and other obstructions to navigation, and the Commission has continued the same character of work during several seasons.

The construction of a lock and dam near the mouth of the river had also been authorized by the river and harbor act of September 19, 1890, but beyond the preparation of plans no active work beyond the acquiring title to land and the erection of a lock house was commenced until 1896.

A project for the construction of a masonry lock 276 feet in length between quoins 52 feet in width and 10½ feet lift had been approved, but no project for the dam had been submitted.

During the fall of 1893, in the improvement of the Missouri River, the Commission had built a dam across the upper outlet of the Osage, which practically lengthened the latter stream about 4 miles, thus lowering the elevation of backwater at the lock site. This necessitated the corresponding lowering of the lower miter sill, and a revision of the project became imperative.

Under the immediate direction of Capt. H. M. Chittenden, Corps of Engineers, U. S. Army, secretary of the Commission, who had been assigned to the charge of the river, a radical change in the project of the lock and dam was submitted to and approved by the Commission.

The lock was diminished in size to 220 feet between quoins and 42 feet in width, and concrete masonry was substituted for rock masonry.

The dam was designed as a fixed dam of concrete masonry, carrying a modified type of drum weir to be operated under ordinary circumstances by hydrostatic head, by which the height in the upper pool could be varied as much as 7 feet. The dam was divided into 10 sections of 75 feet each, separated by piers into which the operating valves for the movable weir were to be placed.

A partial project, as revised, was approved November 23, 1896, and the complete project for the lock and dam received the approval of the Chief of Engineers United States Army, June 29, 1897.

Work under the approved projects was carried on, partly by contract and partly by hired labor, from 1896 up to the fall of 1900, since which time little has been done outside of the care of property.

The present state of the work is as follows: The lock is entirely complete, the fixed and movable dams with their manipulating valves and hydraulic engines are complete over seven of the sections, and the foundation piles under the remaining three sections are driven.

For details of the work see Annual Reports of the Chief of Engineers United States Army, for 1895-1901.

GASCONADE RIVER.

This river was placed in charge of the Commission under a provision of the river and harbor act of August 18, 1894.

No change was made in the original project, approved in 1880, for the improvement of this river, consisting of open channel work in the nature of low dams and training walls on the shoals to concentrate the flow and increase the depth, and the removal of obstructions in the way of navigation.

For details see Annual Reports of the Chief of Engineers United States Army, for 1895-1901.

APPENDIX B.

ANNUAL REPORTS ON COMMERCIAL STATISTICS, BY A. H. BLAISDELL, ASSISTANT ENGINEER.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1902.

COLONEL: I have the honor to submit the following report on the commerce of the Missouri River between its mouth and the lower limits of Sioux City, Iowa, during the calendar year 1901.

The statistics were obtained entirely by correspondence. Personal investigation of the river's trade at small places was not possible, and doubtless the trade of many small shippers, the aggregate of which would be considerable, have been neglected in the tables.

The St. Louis and Hermann Packet Company continued in the trade between St. Louis and Rocheport, 194 miles above the mouth, making weekly trips with their steamer *W. H. Grapevine*, 293 tons, and with two small steamers as feeders. Their trade has materially increased and they have recently added the steamer *Kennedy*, 140 tons, to their line.

The harbor and wharf commissioner of the city of St. Louis reports the arrivals at St. Louis from Missouri River during the year 1901 as 36 packets and 5 boats.

The short-packet trade was carried on by 11 steamers and 2 gasoline boats.

Five steamers engaged in the excursion business at large cities carried an aggregate of 298,424 passengers, and the total number of passengers carried by 28 steamers, including ferry and excursion, was 600,072.

The following table giving the amount of freight carried, towed, and rafted, but not including any ferriage, is an approximation to the river's trade for 1901:

TABLE 1.

Class.	Grain.	Live stock.	Lumber and wood.	Building material and sand.	General merchandise, farm machinery, etc.	Totals.	Mile-tons.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	
Long-trade packets.....	2,751	855	1,114	130	2,956	7,806	999,116
Short-trade packets and miscellaneous boats.....	16,604	3,747	25,461	37,182	4,594	87,588	1,039,767
Sand and wood steamers and barges.....			3,525	459,815		463,340	668,788
Rafts.....			10,935			10,935	195,872
Total.....	19,355	4,602	41,035	497,127	7,550	569,669	2,903,588

The following comparative table gives the totals for the different classes of trade during the last five years:

TABLE 2.

Class.	Total tons carried.				
	1901.	1900.	1899.	1898.	1897.
Long-trade packets.....	7,806	4,397	715	3,641	4,499
Short-trade packets and miscellaneous boats.....	87,588	34,787	37,610	39,245	40,476
Sand and wood steamers and barges.....	463,340	232,395	218,514	252,152	341,710
Rafts.....	10,935	5,727	6,275	5,755	4,344
Mattress brush furnished the United States under contract for use on other works than those of the Missouri River Commission.....				19,000	
Total.....	569,669	277,306	263,114	319,793	391,029

TABLE 3.

Class.	Mile tons.				
	1901.	1900.	1899.	1898.	1897.
Long-trade packets.....	999,116	558,807	98,198	526,304	651,024
Short-trade packets and miscellaneous boats.....	1,089,767	360,378	410,530	522,872	447,433
Sand and wood steamers and barges.....	668,783	460,440	422,606	359,948	473,469
Rafts.....	195,872	103,975	126,432	145,437	164,569
Mattress brush furnished the United States under contract for use on other works than those of the Missouri River Commission.....				375,000	.....
Total.....	2,903,538	1,483,600	1,067,761	1,929,561	1,736,485

There are 42 merchant steam vessels engaged in trade on the Missouri River below Sioux City which receive yearly inspections by the United States Inspector of Steam Vessels, and in addition 14 or more gasoline boats, a few of which exceed 15 tons in measurement and also receive inspection.

Very respectfully, your obedient servant,

A. H. BLAISDELL,
Assistant Engineer.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Missouri River Commission.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1902.

COLONEL: I have the honor to submit the following report on the commerce of the Osage River, Missouri, during the calendar year 1901:

The steamboat traffic was performed principally by the steamers *Osage*, *Frederick*, *J. R. Wells*, and the small steamer *Davutless*. None of these steamers operated above Linn Creek, 110 miles above the mouth. A small gasoline boat is said to be engaged in trade on the upper river but no particulars could be learned of her operations.

The period of low water was much longer than usual and but little log rafting could be done.

Table 1 is a close approximation to the amount of river trade during 1901.

TABLE 1.

Class.	Grain.	Live stock.	Lumber and wood.	Rail-road ties.	Building material and gravel.	Barytes.	Salt.	Produce.	General merchandise, farm machinery, etc.	Total.	Mile-tons.
Packets.....	Tons. 4,232	Tons. 1,058	Tons. 325	Tons.	Tons. 647	Tons. 90	Tons. 218	Tons. 141	Tons. 1,732	Tons. 8,443	277,106
Rafts, etc....	.....	.....	210	55,686	8,000	.....	.....	.....	.....	63,896	2,425,710
Total.	4,232	1,058	535	55,686	8,647	90	218	141	1,732	72,339	2,702,816

206 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Table 2 is a comparative statement of the commerce of the river from 1901 to 1895.

TABLE 2.

Shipments.	1901.	1900.	1899.	1898.	1897.	1896.	1895.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Grain, hay, etc	4, 232	8, 722	4, 077	3, 418	1, 598	2, 651	4, 496
Live stock	1, 058	934	873	1, 038	909	843	1, 368
Lumber, logs, wood, railroad ties	56, 221	76, 583	57, 663	74, 881	66, 175	62, 764	64, 986
Gravel and sand	8, 000	7, 500	9, 945	3, 015	1, 350	4, 500	3, 600
Salt	218	230	371	348	229	416	328
Produce	141	91	165	201	255	188	191
General merchandise, farm machinery, etc.....	2, 379	1, 988	3, 608	1, 385	731	1, 031	1, 739
Barytes.....	90	70					
Total	72, 339	96, 144	76, 702	84, 286	71, 247	72, 393	76, 706

Table 3 gives the comparative commerce of the river expressed in mile-tons.

TABLE 3.

Class.	1901.	1900.	1899.	1898.	1897.	1896.	1895.
Packets and miscellaneous boats	277, 106	545, 107	393, 136	349, 955	178, 695	212, 398	263, 554
Rafts, etc	2, 425, 710	3, 060, 215	2, 968, 121	3, 825, 099	3, 707, 200	3, 839, 483	2, 941, 309
Total	2, 702, 816	3, 605, 322	3, 361, 257	4, 175, 054	3, 885, 895	4, 051, 881	3, 205, 063

Very respectfully, your obedient servant,

A. H. BLAISDELL,
Assistant Engineer.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Missouri River Commission.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1902.

COLONEL: I have the honor to submit the following report on the commerce of the Gasconade River, Missouri, during the calendar year 1901:

The steamboat traffic was principally carried on by two boats of the Hermann Ferry and Packet Company and by one boat of the St. Louis and Hermann Packet Company.

One trip only was made to Vienna, 79 miles above the mouth, but the average distance of steamboat travel was about 53 miles.

On account of a protracted season of low water there was but little rafting done, except in railroad ties.

The following is a close approximation to the amount of trade carried on during 1901:

TABLE 1.

Class.	Grain.	Live stock.	Lumber and wood.	Railroad ties.	Building material and gravel.	Salt.	Produce.	General merchandise, farm machinery, etc.	Total.	Mile-tons.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	
Packets	2, 437	485	2, 396		418	20	97	1, 134	6, 987	308, 226
Rafts.....				12, 473					12, 473	1, 247, 300
Total.....	2, 437	485	2, 396	12, 473	418	20	97	1, 134	19, 460	1, 615, 526

The following table gives the totals in classes of freight shipped during the series of years 1901-1895:

TABLE 2.

Shipments.	1901.	1900.	1899.	1898.	1897.	1896.	1895.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Grain, hay, etc	2,437	4,796	2,100	1,667	1,467	8,197	3,203
Live stock	485	255	414	708	686	1,131	920
Lumber, logs, wood, railroad ties	14,869	15,504	19,864	27,134	27,614	40,350	42,436
Building material, gravel, sand	418	166	6	320	69	493	.....
General merchandise, farm machinery, etc	1,134	733	1,757	872	490	896	780
Salt	20	44	33	57	85	96	83
Produce	97	82	85	223	114	131	122
Total	19,460	21,580	24,259	30,981	30,515	46,294	47,544

The following table gives the comparative commerce of the river, expressed in mile-tons, during the seven years, 1895-1901:

TABLE 3.

Class.	1901.	1900.	1899.	1898.	1897.	1896.	1895.
Packets and miscellaneous boats	369,223	236,992	307,376	162,594	179,777	229,215	197,574
Rafts	1,247,300	1,187,280	1,079,763	1,669,669	2,030,125	3,293,060	3,247,507
Total	1,616,523	1,424,272	1,387,129	1,832,263	2,209,902	3,522,275	3,445,081

Very respectfully, your obedient servant,

A. H. BLAISDELL, *Assistant Engineer.*

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army, President Missouri River Commission.

APPENDIX C.

ANNUAL REPORT ON WATER GAUGES, BY A. H. BLAISDELL, ASSISTANT ENGINEER.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1902.

COLONEL: I have the honor to submit the following report on water gauges during the fiscal year:

The Commission has maintained no water gauges during the year, except one on the Missouri River at Gasconade and one on the Osage River at Lock and Dam No. 1, which were read by the watchmen in care of property.

Below Sioux City the gauge service on 15 of the Missouri River bridges was continued during the year by the several railway and bridge managers, without cost to the Government, and copies of the records were furnished to the Commission.

The service was only moderately satisfactory, but as there has been no gauge inspection for over two years some of the gauges are probably in error.

Weekly reports of the three gauges above Sioux City have been regularly received through the courtesy of the engineer officer in charge.

The highest water below Sioux City during the year occurred during the present month.

The stage was not a very high one. Above Fort Leavenworth it varied from 6.5 to 8 feet above mean low water, and from Kansas City to the mouth from 14 to 11 feet above the same standard.

Very respectfully, your obedient servant,

A. H. BLAISDELL,
Assistant Engineer.

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Missouri River Commission.

APPENDIX D.

ANNUAL REPORT ON MISSOURI RIVER, BY S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Glasgow, Mo., June 20, 1902.

COLONEL: I have the honor to submit the following annual report on Missouri River for the fiscal year ending June 30, 1902:

Operations were confined to the care of plant and other property, surveys and examinations, supervisory work in connection with revetment construction by the Chicago, Burlington and Quincy Railway Company, and special reports.

The total expense incurred during the year was \$2,444.97.

PLANT.

All of the plant and property, excepting that in use in my office at Jefferson City, Mo., had been previously assembled and stored at the Gasconade boat yard. They were watched and cared for throughout the year by a force of three watchmen. The cost of this service, including a prorated charge of \$942.68 for administration, was \$2,130.16.

In compliance with instructions contained in your letter of July 8 and the provisions of the agreement transmitted therewith between yourself and the president of the Chicago and Alton Railway Company, three 100-foot barges, hydraulic grading boat No. 7, and some essential tools accessory to revetment construction were loaned in July to the Chicago and Alton Railway Company for temporary use in the construction of bank revetment in Cambridge Bend, above Glasgow, Mo. The property was repaired, launched, used, and returned by May 9, in like good condition, to its original place in storage, without expense of any kind to the United States; all as provided in the agreement. During this time the railway company extended their revetment in the upper part of the bend (built by them in 1889) 8,250 feet downstream, and also reinforced the old work. The new work was built in accordance with the standard specifications used by the Missouri River Commission.

EXAMINATIONS OF WORKS AND SURVEYS.

The regular annual inspection of the improvement works on the river was not made, owing to a lack of funds. Examinations and surveys were made during the year as follows:

Nebraska City Reach.—The only examination of this reach during the year was made October 12. The following is copied from my report to you in the matter, dated October 15: " * * * The longitudinal dike and Dikes Nos. 1 and 2 have been completely masked by accretions. The height of the shore accretion is nearly uniform and about 6½ feet above standard low water from the saddle, or fourth row, of the longitudinal dike, inshore and downstream beyond Dike No. 5. * * * The loop in the shore line at the lower end of the longitudinal dike was probably due, in part, to eddy action during a high stage. The structure has not been damaged in any way and is practically free of driftwood.

"Dikes Nos. 1, 2, and 3 are in good condition. Considerable driftwood has lodged above the first two and at the shore end of the last. The water below Dike No. 3, inside of a line from its outer end to the stream end of the stem of Dike No. 5, is shoal but moderately swift. There is a great mass of very heavy driftwood lying on the berm of the curved end of Dike No. 5, from its upstream end to about radial bent No. 60. It presents an almost solid wall 6 to 8 feet high. Lower down the berm is practically free from drift. So far as could be seen, the structure has not been damaged, though it is quite possible that some of the timbers underlying the driftwood have been broken. As will be noticed, there is still a waterway through the dike, about where the structure was formerly breached. The volume of its flow is very small and is not causing any cutting. It divides on a high bar formed by the abattis, the right-hand one a very small chute passing through the abattis at its junction with the 2-row pilework on radial No. 87, and the other going partly through and partly around the shore end of the abattis. * * * The accretions above and below the 2-row pilework on radial No. 87 are very high, being nearly on a level with the top of the structure."

In a letter dated at Nebraska City, Nebr., March 6, the bridge watchman states that the ice in the river moved out without injury to any of the works in that reach.

St. Joseph Reach.—On the 12th of October an examination of this reach, from a short distance above the bridge downstream about a mile below the longitudinal dike was made. The conditions then existing were described in my report of October

15, as follows: " * * * The line of principal flow chords the bay from the bridge to Soap Creek, the left bank between those limits being in comparatively quiet water and showing no indication of a recent caving. From Soap Creek to the foot of the revetment built in the fall of 1899 the flow followed the left bank closely, and for a distance of nearly 2,000 feet above the head of the revetment appears to have eroded the bank about as shown. There are indications of recent cutting there, though not caving at the time. The flow past the longitudinal dike is parallel to the structure and continuous on that course about 1,000 feet beyond it before bending in toward the left bank. There is some flow down the left bank, but it is sluggish and probably shallow. * * * As above indicated, the two short lines of abutments on the left bank at the Floyd schoolhouse are in comparatively quiet water, and there has been no recent bank caving there or in that locality. But it is probable that during a higher stage they were exposed to strong current, as both structures are damaged. There are but 3 bents of the upper one and 6 bents of the lower one standing. * * * The revetment has not been damaged in any way, and although threatened to some extent with flanking, as above indicated, is not thought to be in any immediate danger from that source. * * * The longitudinal dike is in excellent condition, having suffered no damage whatever by the flow. * * * From water marks on the piles it appears that the highest stage of river to which the structure has been exposed was about 7 feet above standard low water. The dike has caused the formation of a shore accretion that extends from the head of the structure downstream about 1,000 feet below its lower end. The shore line of accretion extends out to the second row of piles, on the upper half of the dike, then falls away inshore, leaving the foot mattress uncovered. At the third bent from the lower end the shore line leaves the dike, forming a small bay, due to eddy action. * * * The height of the accretion is 5.4 feet above standard low water at the upper end of the pile work, extends inshore level to the main bank from the middle row, and drops off at the middle row on a slope to near the second row of piles. The height of the accretion drops off gradually downstream, being about 1 foot lower at the lower end of the dike. The general elevation of the shore bar below the dike is 2½ to 3 feet above standard low water. The strongest flow past the dike appeared to be out about 125 to 150 feet into the stream, and, as above stated, followed a line parallel to the dike for about 1,000 feet below it. The flow along the outer row of piles was about 3½ to 4 feet per second, and directly on the line of the dike. The second row of piles, where exposed to flow, showed very little "break." After leaving the structure the flow through it passed on in a straight line, but with diminished velocity, and occasional swirls on the line of the outer row extended. Inshore from that line, for a distance downstream of 75 to 100 feet and over to the shore, the water appeared quite dead; below that for 50 feet there was an active upstream flow along the shore bar, causing occasional caving. This flow seemed to lose itself in the dead water under the dikes. A comparison of the water surface at the bridge, as given by the gauge report, with the observed water surface at the dike, shows an apparent lowering of the plane at the latter of 0.7 foot.

Under date of March 10, the bridge watchman at St. Joseph reported that the movement of ice in that reach caused no damage to the works.

Little Blue Reach.—An examination of this reach was made October 17. At that time all of the improvement works were intact, excepting Dike 2 A. And, on the whole, there was marked improvement in the conditions of the flow. Bank head 3 A and its auxiliary radial dike above presented a fine appearance. The accretions formed by the latter extended out to the curved pile wall and from the main bank above to the bank head. There was a breach in Dike 2 A about 100 feet in length about where it was previously breached June 10, 1900. There were 15 bents of the dike connected with the main left bank, 11 of which, counting from the bank, were uninjured; the remaining 4 bents had been forced out of line and badly strained. Several of the bents at the other end of gap were damaged. The volume of water passing through the dike was roughly estimated at 1,000 cubic feet per second. It is not known when the breach occurred, but it was probably during the June rise of 1901.

It is reported that the ice passed out without injury to any of the works in this reach.

Wilhoite Bend, above Glasgow, Mo.—Owing to the accessibility of this reach to the office at Glasgow, Mo., as well as the special interest which attaches to the work, examinations were more frequently made—on July 23, August 14, September 7-10, November 21, March 5, and June 14. A map of the reach, from a hydrographic survey made in September, accompanies this report. It shows the conditions then existing, and also the conditions as they appeared June 14.

No work of any kind has been done on the structures in Wilhoite Bend since December, 1900, and the only damage of consequence sustained by any of them was

the loss, during an ice movement last February, of 5 piles in the outer row of the 2-row work on the 1,000-foot curve of bank head 6 C, near the lower end. As was expected, the June flood of 1901 left a shore accretion 5 to 10 feet above standard low water in the bay between bank heads 5 C and 6 C. The accretion extended from 5 C to 6 C, and from the main bank out to a line that passed through the outer end of the radial dike below 5 C, the outer end of the T dike, and in an easy curve through the 1,000-foot curve of bank head 6 C, at radial No. 24. The conditions of flow in the bend have been quite satisfactory throughout the year, except for a tendency to middle bar growth above and below bank head 5 C. However, this feature became less marked toward the close of the year and the general conditions more nearly ideal.

The left bank for a mile above bank head 4 C has been caving more or less persistently for about two and one-half years, and a bend is being developed there that threatens to seriously disturb the conditions of flow in the lower bend.

Above Rocheport.—The only examination of this reach during the year was made October 18. At that time the main flow impinged with much force against the pile extension work of bank head 1 D, and, after bending somewhat to the curve of the bank head, left it, taking a course nearly parallel to the right bank below and about 450 feet out from it. In the locality of 1,000 to 1,200 feet below the bank head the main flow swung over toward the left bank and effected a crossing about 6,000 feet above the mouth of the creek at Rocheport. Excessive depths of water still prevailed in front of the pile extension of the bank head, but notwithstanding that fact there was noticeable improvement in the situation since the survey of December, 1900—the waterway was wider, the trench less marked, the radius of bending about the structure greater, and the velocity of flow less. There was some cutting of the right bank in the locality of 1,800 to 2,200 feet above the bank head, but elsewhere the bank appeared to be an old one, probably that of the survey of December, 1900. The pile extension work and radial curtains were not injured in any way, except that practically all of the curtain poles had been stripped off of the 2-row work on the 1,000-foot curve.

Considerable driftwood had lodged on the berm as far down as the first 1-row radial curtain, and another lot lower down. The paving of the extended 1 on 2 slope of the bank head had been somewhat disturbed. Several of the fascines of the radial fascine dike had been displaced from the 1 on 2 slope of that structure. The shore line of the fill within and below the pile extension work was about the same, as it was in December, 1900, but the height of the fill had been increased to 7 or 8 feet above standard low water.

It is reported by a resident landowner that during the break-up of ice in the river last February 15 piles in the outer row of the 2-row work on the 1,000-foot curve, at its lower end, had been carried away. From the same source information was received, under dates of June 3 and 11, that there is a destructive eddy immediately above the bank head, and that the pavement of the extended 1 on 2 slope has been partially destroyed.

Chamois reach.—About the middle of August, resident landowners in the vicinity of Chamois, Mo., became alarmed for the safety of the bank head below the town, and requested permission to expend some funds raised by private subscription for the protection of the bank from the foot of the Chamois revetment to the bank head.

Examinations and a partial survey of the reach, on the 22d and 26th of August, clearly showed that there was nothing in the situation to cause alarm. There had been some caving of the right bank in the locality of 400 feet to 1,800 feet above the bank head since the survey of October, 1899, but at no point did the recession of the bank exceed 50 feet, and it appeared that the greater part of the caving had occurred prior to the survey of June 14, 1900. Some slight cutting, of no consequence, was going on at the time.

This bankhead, built in the spring of 1897, has had no work of any kind done upon it since March, 1899. With the exception of the loss of one pile at the upper end of the pile wall the structure had not been injured. The scour stone in the outer wall above water appeared about as it did a year previous. The two groins built in March, 1899, on radials 30 degrees and 41 degrees 27 minutes, respectively, above middle ordinate, caused a noticeable disturbance in the flow past the bankhead. The swiftest flow was from the groins downstream some 500 feet on a line passing through the ends of the groins and a point in the directrix 200 feet out from the pile wall. After passing the bankhead the main flow crossed over to the left bar, though there was a chute carrying considerable flow that impinged against the main right bank about 1,800 feet below the bankhead and caused more or less bank caving.

No other examination was made during the year of any portion of the 45 miles of improved river in first reach, and therefore a definite statement can not be made of

the present condition of the improvement works therein nor of the conditions of the flow. Enough is known, however, to warrant the statement that there have been no extensive injuries to the works, and no really important changes in the conditions of the flow. The works in the vicinity of Jefferson City when last seen in February were in good condition.

Howard Bend reach, above St. Charles, Mo.—This reach was examined but once during the year, October 19.

The three bankheads—4 F, 5 F, and 6 F—and the dikes above bankhead 6 F, were in excellent condition.

A change in the approach above had greatly disturbed conditions of the flow in Howard Bend. Bankhead 4 F was partially masked; there was a funneling effect at 5 F, the flow in its approach from above being apparently divided by a middle ground was concentrated in front of the bankhead and more or less scattered below; the main flow chorde the bay from 5 F to 6 F and was actively cutting the right bank below the latter structure. The dikes above 6 F—sheer dike, longitudinal and stem—were in comparatively quiet water, and well backed up by a deposit 2 to 4 feet high above standard low water, and extending from the shore end of the sheer dike down to the pile work on the bankhead curve. There was some active caving of the bank above 5 F, but none between 5 F and 6 F.

Upper Kaw Bend, above Kansas City, Mo.—On complaint of landowners on the left bank of the river in Upper Kaw, Bend you directed in a letter dated January 31 that an examination be made of some pile dikes then under construction at and near the head of the chute separating Goose Island from the Kansas shore.

The examination was made February 3, and developed the facts that the dikes were being built by Mr. Herbert H. Clark, of Kansas City, Mo., for land reclamation purposes, and would probably result in closing one of the high-water channels. A report in the matter, with a map of the river showing the location, character, and extent of the work, was submitted to you under date of February 11.

The total cost of the examinations and surveys during the year was \$314.81.

REVTMENT NEAR RULO, NEBR., BY THE CHICAGO, BURLINGTON AND QUINCY RAILWAY COMPANY.

Under authority by the War Department, dated June 29, 1901, the Chicago, Burlington and Quincy Railway Company constructed during the year 7,975 linear feet of bank revetment on the left bank of the river in Rush Bottom Bend, above Rulo, Nebr.

The work was carried on under arrangements made in compliance with the directions of the Chief of Engineers United States Army, as contained in the sixth indorsement on the letter by Hon. F. H. Cockrell, addressed under date of June 20, 1901, to the honorable the Secretary of War, and your letter of instructions to me dated July 8, 1901.

As originally projected the work contemplated the extension of the revetment built by the Missouri River Commission in 1900 downstream some 7,100 feet to a junction with a piece of bank revetment 2,200 feet in length, built by the railway company in 1900. Later on it was decided to extend also their old work 1,075 feet downstream.

Work was commenced in July, but was suspended after putting in some temporary fascine protection in the locality of 1,500 to 1,900 feet below the United States revetment. Operations were resumed in the latter part of September and continued, with some interruptions on account of weather conditions, to completion on May 3.

As completed the work is in three sections, as follows:

Upper section.—From the lower end of United States revetment of 1900, 5,850 feet downstream to near railway company's old pile dike, the lower end overlapping the shore protection work of the dike.

Middle section.—From 50 feet below the old dike, 1,050 feet downstream, overlapping at the upper end the shore protection work of the old dike and at the lower end the revetment built by the railway company in 1900. (The last-mentioned work is 2,200 feet in length.)

Lower section.—From the lower end of the railway company's revetment of 1900, 1,075 feet downstream, the upper end overlapping the old work.

There is therefore a continuous bank protection extending from the upper end of the United States revetment at the head of the bend 15,650 feet downstream.

It was the expressed purpose of the railway company to build the new revetment in accordance with the standard specifications used by the Missouri River Commission, but this was not done until their attention had been called to the matter after 1,940 linear feet of bank (from the foot of the United States revetment downstream)

212 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

had been covered with work which did not conform with the standard. The departures from standard specifications were not of primary importance, except in the upper 300 linear feet of work, and a specially heavy subaqueous ballasting and spalling of the upper bank did much toward correcting the faults.

By your direction the following materials belonging to the United States were turned over to the railway company for expenditure in the construction of the revetment: 84 cords willow brush; 3,663.141 tons riprap stone; 18,428 pounds wire strand, three-eighths inch galvanized; 1,145 clips for wire strand.

These materials had been acquired and paid for under the allotment for "At Rulo, Nebr.," sundry civil act of June 6, 1900.

The total cost of the 7,975 linear feet of revetment was given at \$62,839.05 in the sworn statement by the railway company's chief engineer, Mr. I. S. P. Weeks, which was transmitted to you with my final report upon the work under date of May 15.

Mr. F. G. Kirwan, under whose direct supervision as agent for the United States the work was carried on, reported on the work October 1, two days in advance of the commencement of mattress construction, and was in constant attendance until the completion of the revetment.

I made two inspections of the work, October 11 and May 2.

SPECIAL REPORTS.

A special report upon the merits of the so-called anchor riprap system, as used on Missouri River, was prepared by your direction and submitted under date of November 15.

In a letter dated May 10 you directed me to investigate and report upon a complaint which was filed with the Secretary of War by Charles H. Wilson, master of the ferryboat at Boonville, Mo., against Mr. Charles Meierhoffer. The complaint was that the operations of the latter's sand dredge and gravel screens are leaving bars in the Boonville front, which make it difficult for a boat to cross from one side of the river to the other.

The matter was investigated as well as possible through inquiries and correspondence, and made the subject of a special report to you dated May 29.

Very respectfully, your obedient servant,

S. WATERS FOX, *Division Engineer.*

Col. AMOS STICKNEY,

Corps of Engineers, U. S. Army, President Missouri River Commission.

APPENDIX E.

ANNUAL REPORT ON OSAGE RIVER, MISSOURI, BY S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Glasgow, Mo., June 19, 1902.

COLONEL: I have the honor to submit the following annual report pertaining to Osage River for the fiscal year ending June 30, 1902:

Operations were confined to the care and preservation of the plant and other property in storage at Lock No. 1, keeping the lock free from driftwood, and in reinforcing the apron sheathing fastenings. The total expense incurred during the year was \$2,204.97.

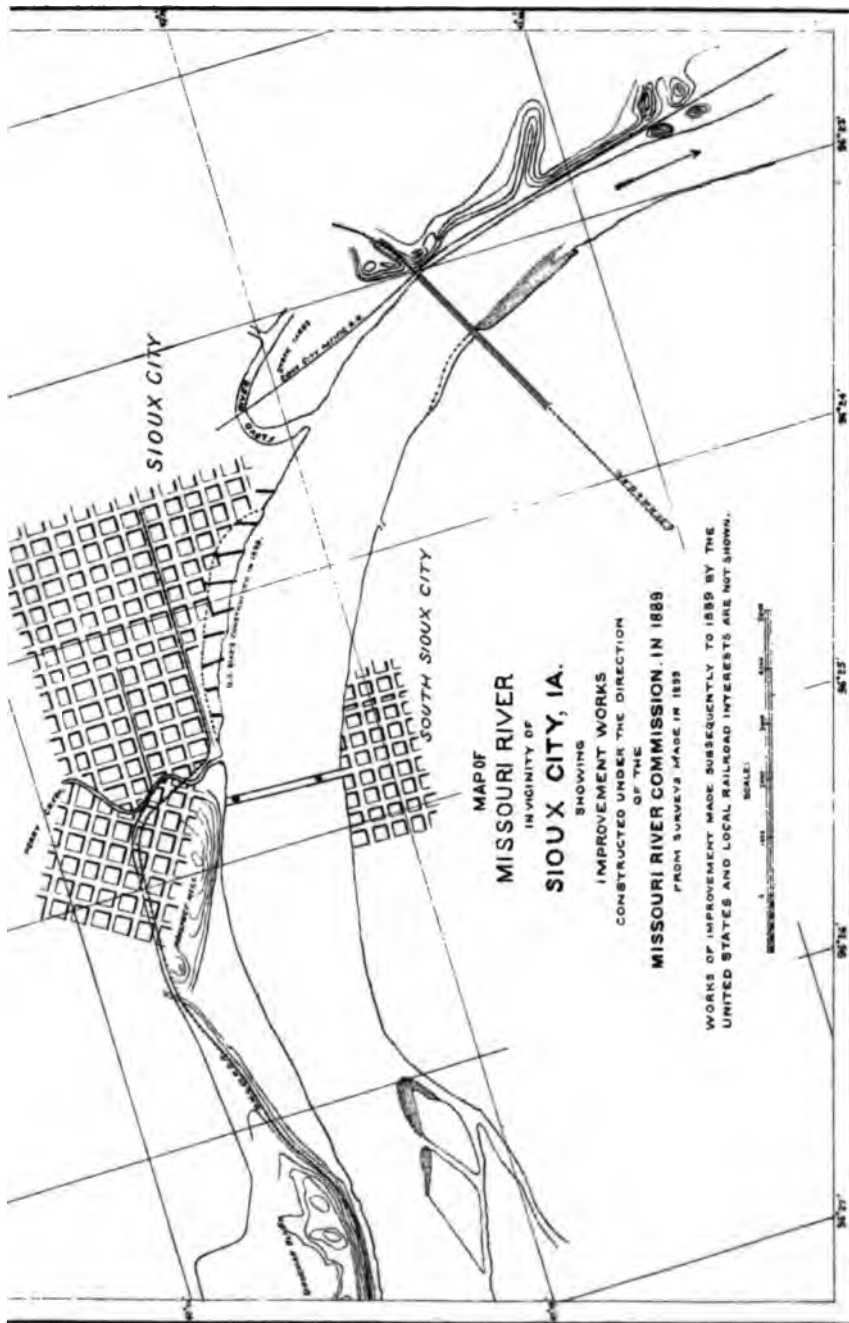
Resident Watchman Louis Seidel was continuously employed throughout the year, and was given such help from time to time as required.

The lock keeper's house and several small outbuildings were given two coats of paint each.

For want of a proper harbor, and because they were badly leaking, four of the five hulls were beached below the lock in July. In the spring they were calked to light-draft lines, and during a rise in June were floated back into harbor near the lock. The cost of plant repairs during the year was \$68.69.

A small force of men was employed from the 14th to the 20th of March in freeing the lock of driftwood which had lodged in it during a sharp rise. The cost of this work was \$26.25.

An examination of the dam in September disclosed the necessity for reenforcing the apron sheathing fastenings. In a letter dated September 17 you authorized the work and directed that one-half-inch driftbolts, long enough to pass through the sheathing and rear stringers, be used, the bolts to be driven in seven-sixteenth-inch holes bored in planes normal to the plane of the apron, but canted alternately in







1775

Year	Actual (%)	Projected (%)
1950	7.5	-
1960	8.5	-
1970	9.5	-
1980	10.5	-
1990	11.5	-
2000	12.5	10.5
2010	-	13.5
2020	-	15.5
2030	-	17.5
2040	-	18.5
2050	-	18.5

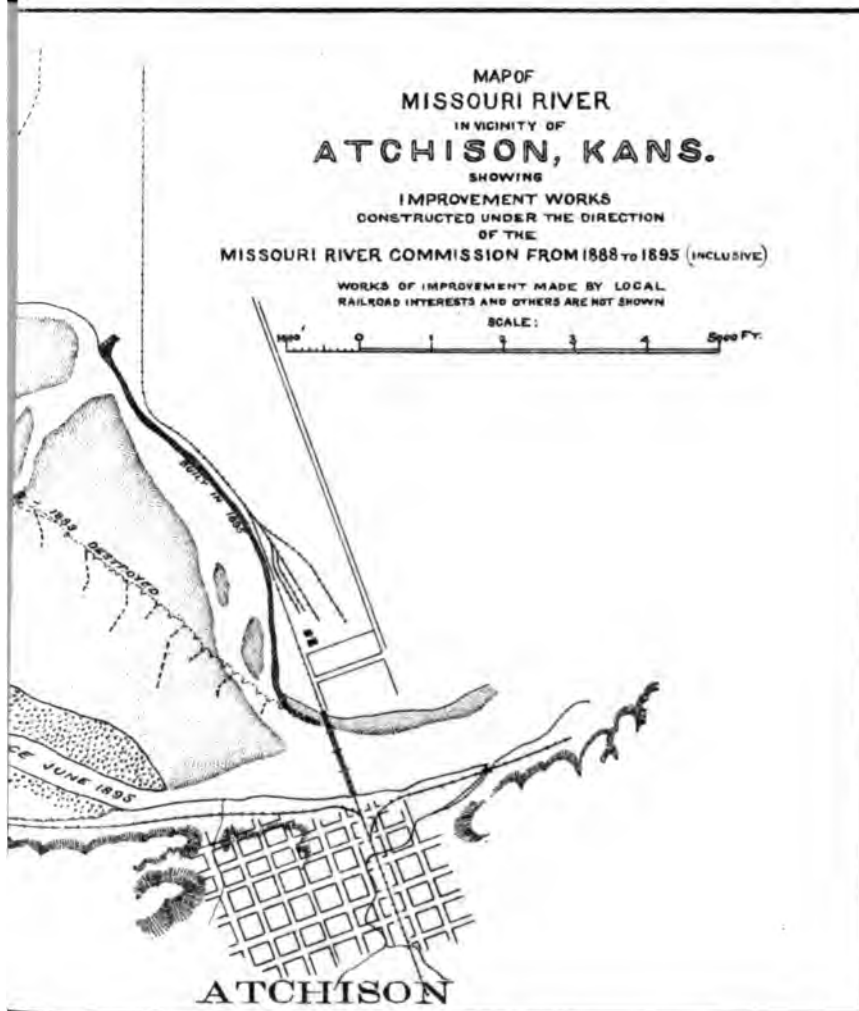
1



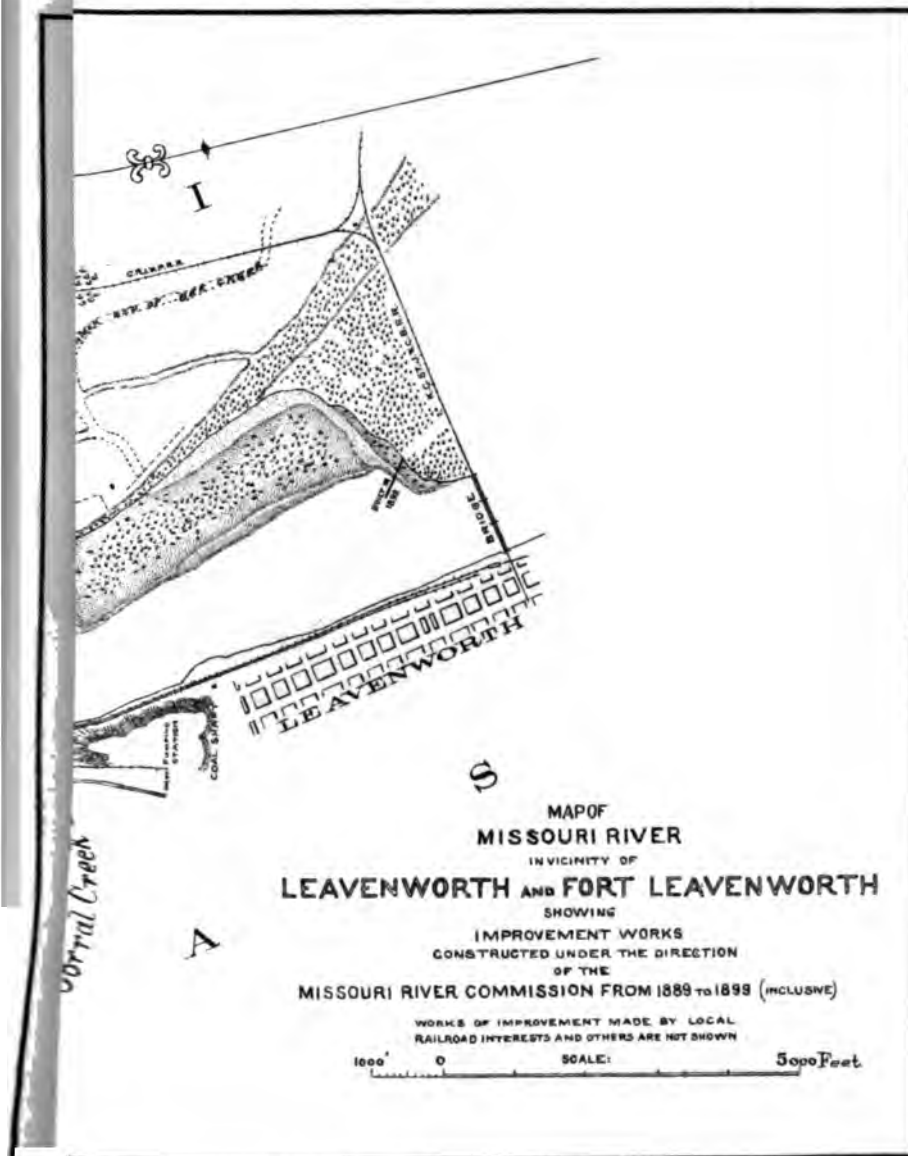


30 (INCLUSIVE)

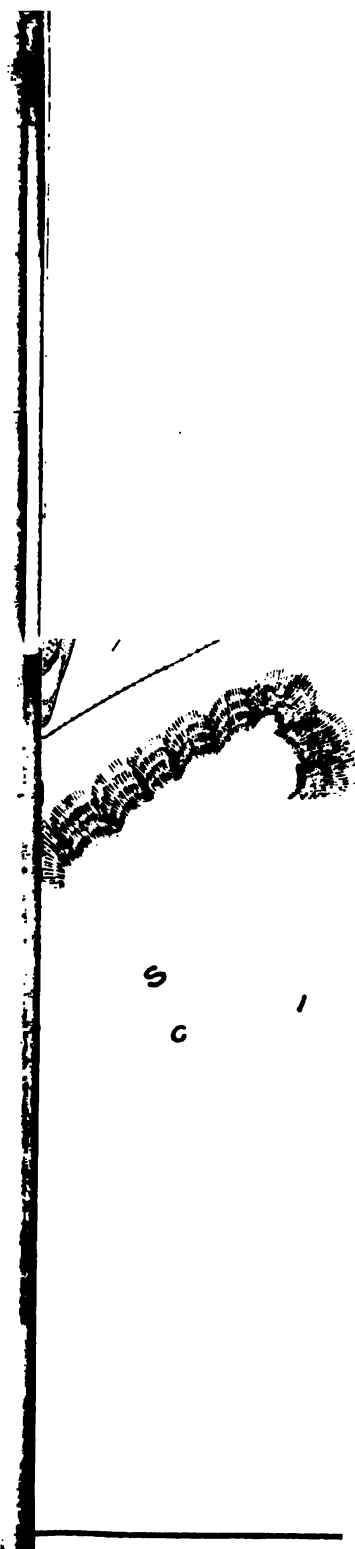










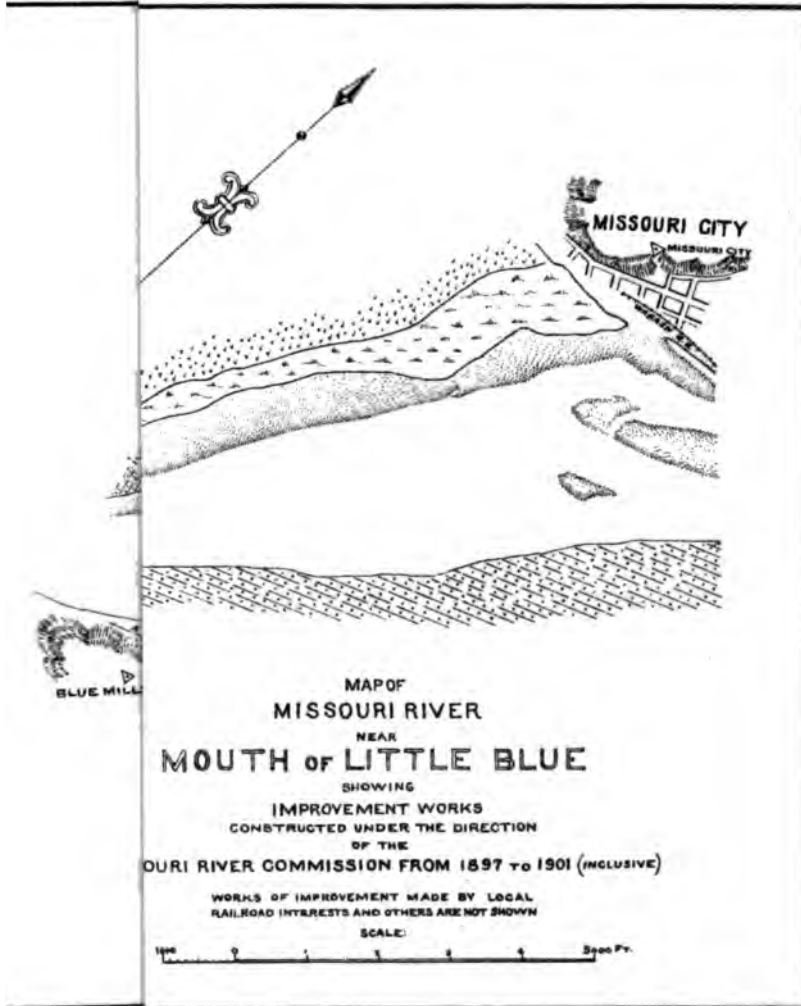


S

C

I





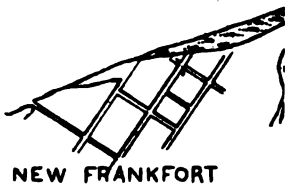
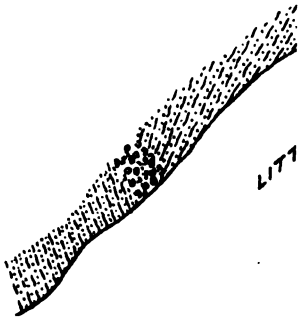


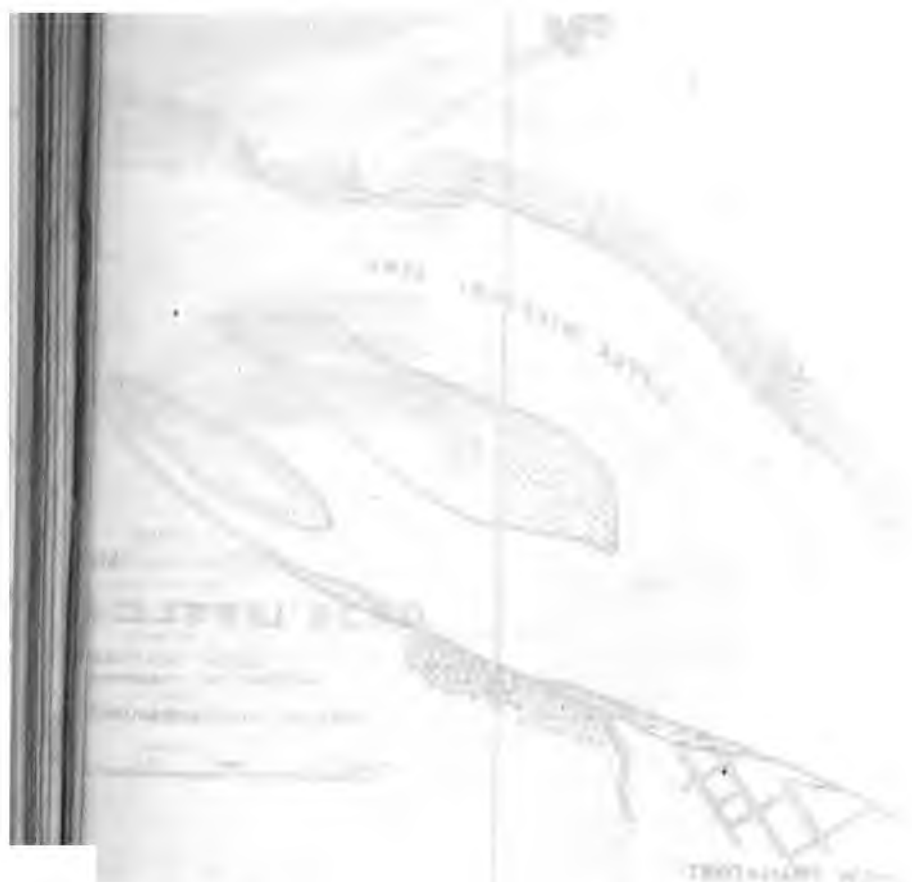


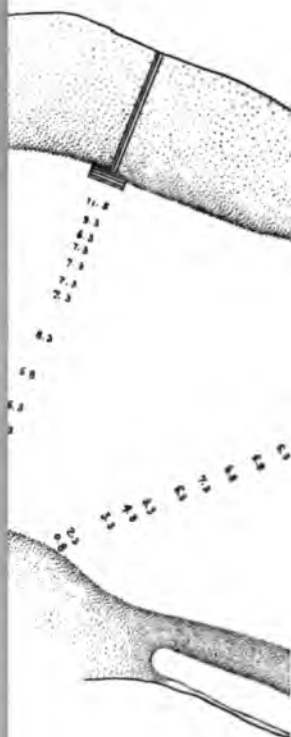


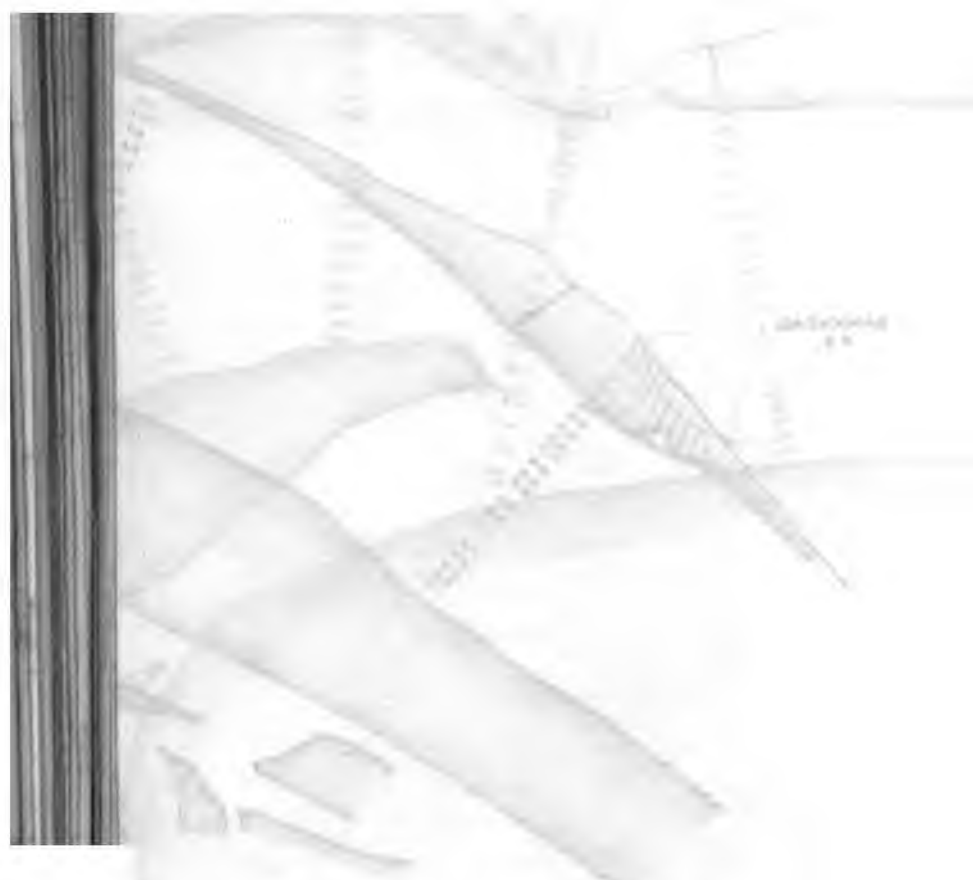


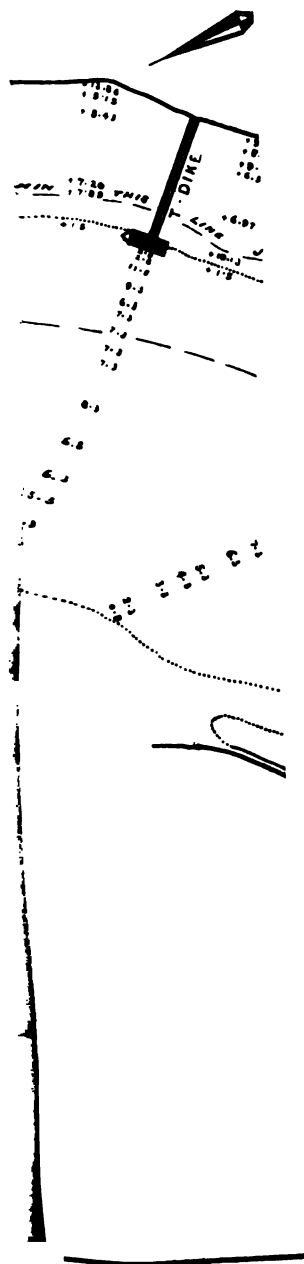














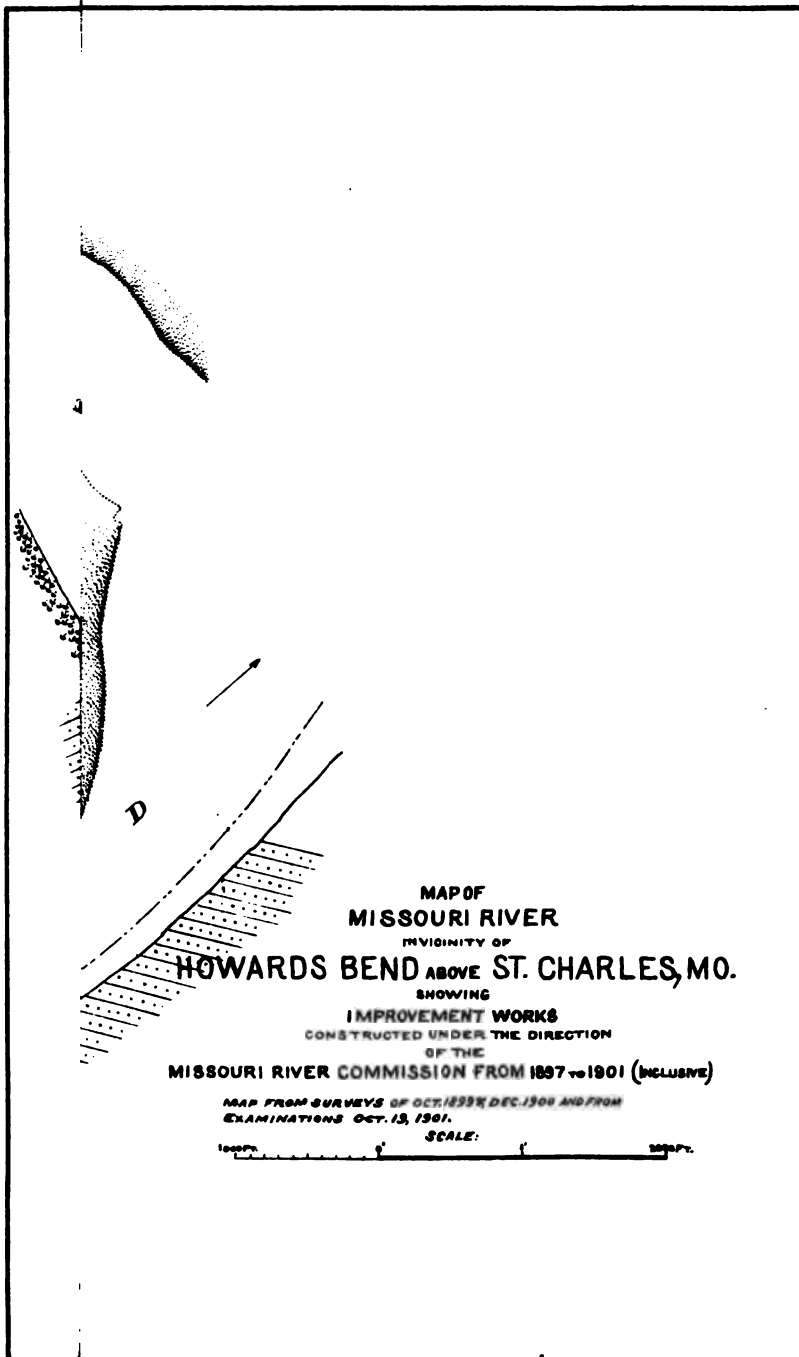
LE



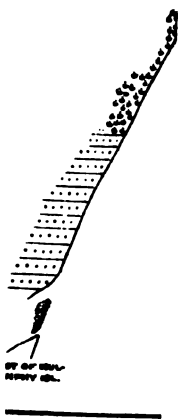
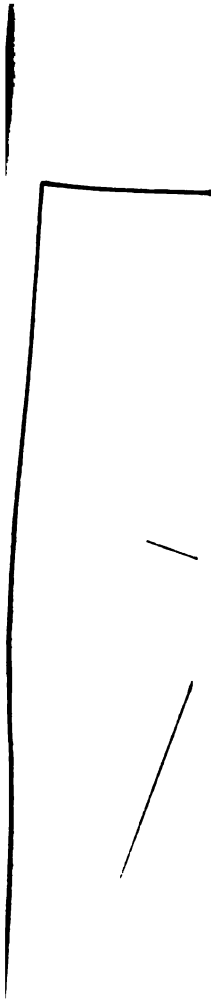


Fig 57 2

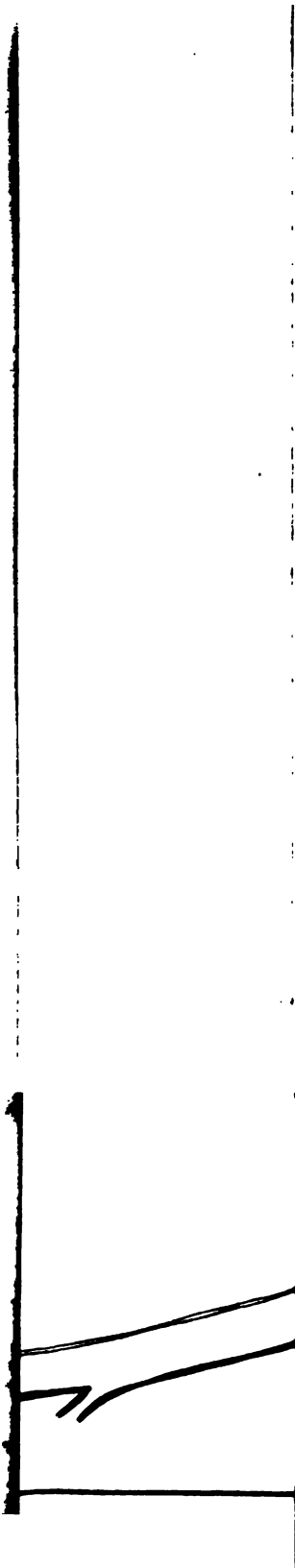




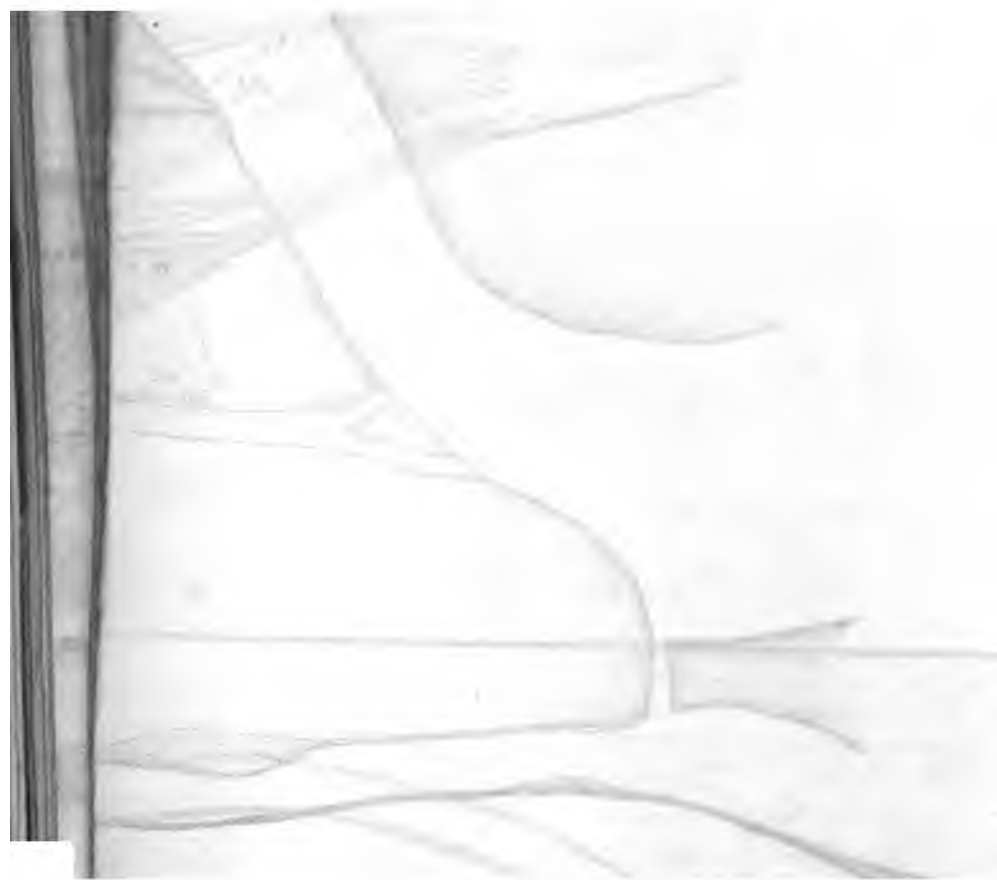




7



Eng 57 2



opposite directions in the line of the dam. Two men, in addition to the resident watchman, were employed in this work from November 4 to December 6, during which time 2,478 bolts were driven as directed in three rows extending full length of the existing dam. The fourth or bottom row could not be driven, the stage of river being too high. The cost of this work was \$171.48.

Very respectfully, your obedient servant,

S. WATERS FOX, *Division Engineer.*

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Missouri River Commission.

APPENDIX F.

ANNUAL REPORT ON GASCONADE RIVER, MISSOURI, BY S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Glasgow, Mo., June 19, 1902.

COLONEL: I have the honor to submit the following annual report pertaining to the Gasconade River for the fiscal year ending June 30, 1902:

No work was done on this river during the year. The plant and property belonging to the improvement of the river are in storage at the U. S. Boatyard, Gasconade, Mo., and at Lock No. 1, Osage River. The expense for care of plant and property during the year was \$794.42.

Very respectfully, your obedient servant,

S. WATERS FOX, *Division Engineer.*

Col. AMOS STICKNEY,
Corps of Engineers, U. S. Army,
President Missouri River Commission.

MODIFICATION OF HARBOR LINES ALONG MISSOURI RIVER IN FRONT OF KANSAS CITY, MISSOURI, AND KANSAS CITY, KANSAS.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
St. Louis, Mo., August 1, 1901.

GENERAL: I have the honor to forward herewith, for consideration by the Department, a resolution submitted by letter ballot to the members of the Missouri River Commission recommending a revision of the established harbor lines at Kansas City, Mo., and Kansas City, Kans., as approved by the Secretary of War on December 9, 1893:

RESOLUTION OFFERED BY COLONEL STICKNEY.

Resolved, That it be recommended that the action establishing the harbor line for the right bank of the Missouri River in front of the cities of Kansas City, Mo., and Kansas City, Kans., description and map of which were submitted by the Missouri River Commission in its report dated September 14, 1893, the approval of which was recommended by the Chief of Engineers, U. S. Army, October 5, 1893, and published in the Annual Report of the Commission of 1894, be rescinded and that the line described in the accompanying paper and shown on the accompanying map be substituted therefor. This substitution having become necessary by reason of the fact that the description of the original harbor lines was based upon an erroneous map of the locality.

On this resolution all the members of the Commission voted in the affirmative.

The survey made in 1893 on which the original harbor line was based was a local one and contained errors which later surveys have corrected. These errors have but slight effect on the harbor line above the piers of the "Winner" bridge, the differences being scarcely apparent on the scale of 250 feet to 1 inch on which the map is drawn.

Below the "Winner" bridge the harbor line as now recommended varies from 0 to 35 feet on either side of the original line until its junction with the east bottom revetment, where the revised line is as much as 196 feet northward of the original line.

The errors in the survey of 1893 appear to have arisen from the surveyor's assumption that the land section lines were on true meridians, whereas they were all found to have azimuths, in one instance as large as $2^{\circ} 13'$.

The description of the harbor line, as now recommended by the Commission, makes no changes in the original line, except such as are advisable on account of errors found in the original map.

The new description and new map^a are submitted for the action of the Chief of Engineers and Secretary of War.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Colonel, Corps of Engineers,
President, Missouri River Commission.*

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 6, 1901.

Respectfully submitted to the Secretary of War with recommendation that the revised harbor lines for the right bank of the Missouri River in front of the cities of Kansas City, Mo., and Kansas City, Kans., delineated on the accompanying map and described in a separate paper herewith, be approved.

It has been found that the survey on which the original harbor line, approved by the Secretary of War December 9, 1893, was based, contained errors, and the action now recommended is necessary on that account.

The map has been prepared for the signature of the Secretary and will be substituted for the one formerly approved.

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers, U. S. Army.

[Second indorsement.]

WAR DEPARTMENT,
August 7, 1901.

Approved as recommended by the Chief of Engineers.

WM. CARY SANGER,
Acting Secretary of War.

^a Not printed.

DESCRIPTION OF A LINE DEFINING THE LIMITS OF ALLOWABLE CONTRACTION IN WIDTH OF THE LOW-WATER WAY OF THE MISSOURI RIVER IN FRONT OF KANSAS CITY, MO., AND KANSAS CITY, KANS.

This description depends upon the map of the established harbor line on the right bank of the Missouri River in front of Kansas City, Mo., and Kansas City, Kans., approved by the Secretary of War August 7, 1901.

The line to be as shown on the harbor-line map, points of which may be found as follows:

Point 1.—Foot of the old bank revetment at Kaw Point.

Point 2.—Intersection of a line 34 feet south of and parallel to the north line of Washington avenue, Kansas City, Kans., with a prolongation of a line through point J of the established harbor-line near mouth of Kansas River, and the east cylinder of the south pier of Missouri Pacific Railroad across Kansas River.

Point 3.—Approximately determined by the intersection of the prolongation of line c I of the established harbor line with the prolongation of a line joining point U of the established harbor line and point 6 of the line being described.

Point 4.—Intersection of the prolongation of a line 20 feet north of and parallel to the center line of Ohio avenue with the prolongation of a line joining points f and P of the established harbor line.

Point 5.—Intersection of the prolongations of lines joining points f Q and g R of the established harbor line.

Point 6.—Point of tangency of a curve drawn through points 1, 2, 3, 4, and 5 with prolongation of a straight line drawn through points 7 and 8 of the line being described, situated about 1,100 feet above the center line of the Hannibal and St. Joseph Railroad bridge.

Point 7.—Extreme northern point of the stone foundation of the third pier north of the pivot pier of the Hannibal and St. Joseph Railroad bridge.

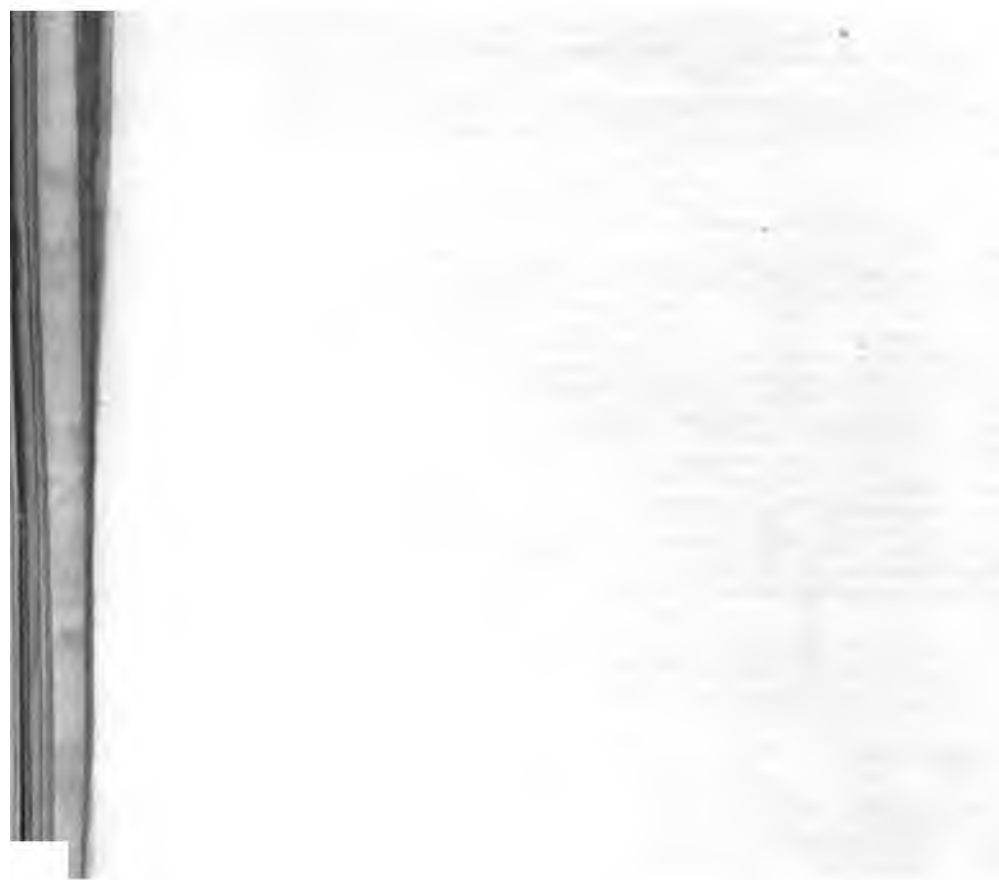
Point 8.—A point 20 feet north of the northernmost point of the stone foundation of the first river pier of the so-called Winner Bridge, counting from the north bank.

Point 9.—Point of tangency of the straight line between points 7 and 8 prolonged, with the foot of the bank revetment about 2,050 feet below the Winner Bridge.

Point 10.—The point of intersection of land section lines between sections 23 and 24 prolonged with the foot of the bank revetment.

Below point 10 the line of allowable low-water contraction is parallel with the established harbor line at a uniform distance of 825 feet.

The above-described line defines the limits beyond which, on the channel side, no obstructions will be permitted. Shoreward from this line constructions will be permitted, with the proviso that nothing shall project above planes starting at the line at an elevation of low water (which is indicated by a gauge height of 308.5 feet above St. Louis city directrix at the Hannibal and St. Joseph Railroad bridge) and rising toward the shore with an inclination of 1 on 8.



- Aransas Pass, Tex., improvement of i, 341; ii, 1386
 Aransas Pass Harbor Company (*see* Aransas Pass) i, 341; ii, 1386
 Arcata, Cal. (*see* Humboldt Harbor) i, 533; iii, 2360
 Arch Rock, San Francisco Harbor, Cal., removal of i, 526; iii, 2348
 Arkansas River:
 Gauging (*see* Mississippi River Commission) i, 578; S., 3, 52
 Improvement of i, 354; ii, 1571
 Armament. *See* Fortifications.
 Arthur Kill, N. Y. and N. J.:
 Improvement of i, 162; ii, 1012
 Removal of wreck i, 177; ii, 1038
 Arthur Lake, La. (*see* Mermentau River) i, 323, 324; ii, 1343
 Ashepoo River, S. C., waterway via i, 249; ii, 1171
 Ashland, Ky., ice harbor (*see* Ohio River) i, 399; ii, 1842
 Ashland Harbor, Wis., improvement of i, 433; iii, 2027
 Ashley River, S. C., bridge across i, 587
 Ashtabula Harbor, Ohio:
 Improvement of i, 503; iii, 2283
 Removal of wreck i, 506; iii, 2293
 Water levels i, 602; iv, 2763, 3032
 Assawoman Bay, Del., waterway via i, 188; ii, 1060
 Assistants:
 Civilian, to engineer officers i, 38
 On duty in Office of the Chief of Engineers i, 612
 Astoria, Oreg. (*see* Columbia River below Tongue Point) i, 556; iii, 2398
 Atchafalaya River, La.:
 Gauging (*see* Mississippi River Commission) i, 578; S., 3, 52
 Rectification of mouth by Mississippi River Commission i, 578; S., 3, 31
 Atlantic Basin, Buttermilk Channel, Brooklyn, N. Y., harbor lines i, 579, 983
 Atlantic Coast Line, bridge of i, 583
 Atlantic Ocean, removal of wreck off Absecon light, N. J. i, 190; ii, 1062
 Atlantic (South) States, removal of water hyacinths from Florida
 waters i, 272; ii, 1215
 Augusta, Ga., bridge across Savannah River below i, 591
 Aux Bees Scies Lake, Mich. (*see* Frankfort Harbor) i, 473; iii, 2176

B.

- Back Bay of Biloxi, Miss. (*see* Biloxi Harbor) i, 305; ii, 1312
 Back Cove, Portland, Me. (*see* Portland) i, 76, 842
 Back River, Mass. *See* Weymouth River.
 Bad River, Mich., improvement of i, 478, 479
 Bagaduce River, Me., improvement of i, 67, 833
 Bailey, Electa (schooner), removal of wreck of i, 122, 911
 Baker, W. C., bridge of i, 588
 Ballard, Wash. (*see* Puget Sound-Lake Washington waterway) . i, 568; iii, 2417, 2419
 Baltimore and Potomac Railroad Company:
 Bridge, highway, across Potomac River at Washington, D. C., to replace
 Long Bridge i, 592
 Bridge of, across Potomac River at Washington, D. C., to replace Long
 Bridge i, 582
 Baltimore Harbor, Md.:
 Bridge across Bear Creek near Sparrows Point i, 588
 Defenses of i, 7, 22, 699
 Improvement at Spring Garden i, 194; ii, 1071
 Improvement of channel to i, 192; ii, 1067
 Improvement of channel to Curtis Bay i, 194; ii, 1070
 Bangor Harbor, Me. (*see* Penobscot River) i, 68, 834
 Barge No. 3, removal of wreck of, in Buffalo Bayou, Tex. i, 342; ii, 1391
 Bar Harbor, Me.:
 Construction of breakwater i, 64, 830
 Defenses of i, 7, 14, 621
 Barkalow, M. P. (schooner), removal of wreck of i, 506; iii, 2293
 Barren River, Ky., operating and care of lock and dam i, 427; iii, 1988
 Bartholomew Bayou, La. and Ark.:
 Bridge near Portland, Ark i, 582
 Improvement of i, 347; ii, 1415
 Survey of (*see* Ouachita and Black rivers) i, 354; ii, 1435

- Battalions of Engineers i, 38, 40, 42, 44, 607, 802, 811, 814, 818; iv, 3054
- Batteries:
- Dynamite i, 11
 - Gun and mortar i, 6, 8, 38
- Bayonne, N. J., bridge across Newark Bay to Elizabethport i, 589
- Bay Ridge Channel, New York Harbor, N. Y., improvement of i, 148, 974
- Bayside Channel, New York Harbor, N. Y., improvement of i, 146, 969
- Bear Creek, Md., bridge near Sparrows Point i, 588
- Beaufort County, N. C., bridge of i, 583
- Beaufort Harbor, N. C.:
- Improvement of i, 231; ii, 1137
 - Improvement of waterway to Newbern i, 231; ii, 1136
 - Improvement of waterway to New River i, 232; ii, 1138
- Beaufort Harbor and River, S. C.:
- Defenses of Port Royal Sound i, 7, 26, 723
 - Improvement of river i, 250; ii, 1172
 - Improvement of waterway to Charleston, S. C. i, 249; ii, 1171
 - Improvement of waterway to Savannah (*see* Savannah Harbor) .. i, 251; ii, 1177
 - Removal of logs from waterway to Charleston, S. C. i, 251; ii, 1173
- Beaumont, Tex., furnishing of funds by citizens of, for Sabine Lake channel i, 328; ii, 1347
- Beaver (canal chunker), removal of wreck of i, 178; ii, 1040
- Beaver Dam, N. J., bridge across Oranoken Creek i, 586
- Beechridge, Ill., prevention of break in Mississippi River at i, 369; ii, 1606
- Belle River, Mich., improvement of i, 484; iii, 2195
- Bellingham Bay, Wash. (*see* New Whatcom Harbor) i, 573; iii, 2429
- Benton Harbor, Mich.:
- Bridges across Pawpaw River i, 590, 591
 - Improvement of St. Joseph Harbor i, 460; iii, 2141
- Benton Harbor Canal, Mich. (*see* St. Joseph Harbor) i, 460; iii, 2141
- Bergen Turnpike Company, bridges of i, 584
- Berkley, Va., removal of wreck in Southern Branch, Elizabeth River. i, 226; ii, 1126
- Beverly Harbor, Mass., improvement of i, 90, 859
- Biddeford Pool Harbor, Me., removal of wreck i, 95, 865
- Big Assawaman Bay, Del., waterway via i, 188; ii, 1060
- Big Barren River, Ky., operating and care of lock and dam i, 427; iii, 1988
- Big Hocking River, Ohio, ice harbor in Ohio River near mouth of ... i, 399; ii, 1842
- Big Sandy River, W. Va. and Ky.:
- Improvement of, including Tug and Levisa forks i, 417; iii, 1946
 - Operating and care of lock and dam i, 419; iii, 1952
- Big Sarasota Bay, Fla., improvement of i, 275; ii, 1218
- Big Sioux River, S. Dak., ice harbor at Sioux City, Iowa i, 385; ii, 1687
- Big Stone Lake, Minn., survey of i, 381; ii, 1684
- Big Sunflower River, Miss., improvement of i, 351, 353; ii, 1433
- Biloxi Harbor, Miss., improvement of i, 305; ii, 1312
- Biscayne Bay, Fla., improvement of i, 271; ii, 1212
- Bismarck Harbor, N. Dak. (*see* Missouri River) i, 382; ii, 1687
- Black Lake, Mich., improvement of Holland Harbor i, 464; iii, 2152
- Black River, Ark. and Mo., improvement of i, 361; ii, 1585
- Black River, La.:
- Final report on survey i, 354; ii, 1435
 - Improvement of i, 346; ii, 1410
- Black River, Mich.:
- Improvement at mouth i, 481; iii, 2191
 - Improvement at Port Huron i, 483; iii, 2193
- Black River, Miss., bridge near Fishers Ferry i, 585
- Black River, N. C., improvement of i, 233, 234; ii, 1141
- Black River, Ohio, improvement of Lorain Harbor i, 499; iii, 2264
- Black River Junction, Wash., bridge across White River i, 584
- Black Rock Harbor, Conn. (*see* Bridgeport Harbor) i, 133, 937
- Black Rock Harbor, N. Y.:
- Improvement of Buffalo entrance to i, 511; iii, 2313
 - Improvement of Lake Erie entrance to i, 511
- Black Warrior River, Ala.:
- Improvement above Tuscaloosa i, 295; ii, 1285
 - Improvement below Tuscaloosa i, 296; ii, 1289, 1290
 - Operating and care of locks and dams i, 300; ii, 1300
 - Revised estimates of cost of locks and dams above and below Tuscaloosa iii, 1288, 1293

- Block Island, R. I.:
 Construction of harbor of refuge..... 1, 120, 908
 Improvement of Great Salt Pond 1, 121, 909
- Blood River, La. (*see* Tickfaw) 1, 311, 312; II, 1319
- Blossom Rock, San Francisco Harbor, Cal., removal of 1, 526; III, 2348
- Blounts Creek, N. C., bridge in Beaufort County..... 1, 583
- Boards:
 For highway bridge at Washington, D. C 1, 592; IV, 2652
 Of Ordnance and Fortification..... 1, 6
 On Fortifications or other Defenses (Endicott Board)..... 1, 6
 On Torpedo System..... 1, 6
 The Board of Engineers..... 1, 6, 7, 615
- Boat railway, Columbia River, Oreg. and Wash 1, 546; III, 2376
- Boats:
See also Dredge and Snag boats, and Wrecks.
 Rules governing running of steamers on certain streams..... 1, 580
- Bœuf River, La. and Ark.:
 Bridge near Rayville, La..... 1, 582
 Improvement of..... 1, 347, 348; II, 1416
 Survey of (*see* Ouachita and Black rivers)..... 1, 354; II, 1435
- Bogue Chitto, La., improvement of..... 1, 311; II, 1316
- Bogue Falia, La., improvement of..... 1, 311, 312; II, 1318
- Bogue Sound, N. C., improvement of waterway via..... 1, 232; II, 1138
- Boston Harbor, Mass.:
See also Mystic River.
 Bridge across Fort Point Channel at Broadway..... 1, 587
 Bridge across Fort Point Channel at Cove street..... 1, 588
 Defenses of..... 1, 7, 16, 641
 Harbor lines at Somerville 1, 579, 887
 Improvement of..... 1, 98, 871
- Boston, Revere Beach and Lynn Railroad Company, bridge of..... 1, 586
- Boulevards. *See* Roads.
- Bourne, Mass., bridge across Buttermilk Bay..... 1, 583
- Bowery Bay, East River, N. Y., harbor lines at Steinway 1, 579, 964
- Brandywine Creek or River, Del.:
 Bridge at Wilmington 1, 587
 Improvement of Wilmington Harbor 1, 185; II, 1053
- Brandywine Railway Company, bridge of..... 1, 587
- Branford Harbor, Conn., improvement of 1, 128, 929
- Brazos River, Tex.:
 Improvement between Richmond and Old Washington 1, 339; II, 1385
 Improvement between Velasco and Richmond 1, 337, 339; II, 1379, 1385
 Improvement of mouth..... 1, 340; II, 1386
- Brazos River Channel and Dock Company (*see* Brazos River) 1, 340; II, 1386
- Brazos Santiago Harbor, Tex., improvement of..... 1, 342; II, 1390
- Breton Bay, Md., improvement of..... 1, 206; II, 1088
- Bridge Creek Landing, Va., wharf at..... 1, 596; IV, 2717
- Bridgeport Harbor, Conn., improvement of 1, 133, 937
- Bridges:
 Alteration of, obstructing navigation..... 1, 589, 590
 Aqueduct Bridge, Washington, D. C., repair of 1, 591; IV, 2651
 Construction of, across navigable waters..... 1, 581, 583
 Highway bridge, Washington, D. C., to replace Long Bridge ... 1, 592; IV, 2652
 In military divisions and departments..... 1, 605; IV, 3049
 Memorial Bridge, Washington, D. C 1, 591; IV, 2652
 Railroad bridge, Washington, D. C., to replace Long Bridge 1, 582
 Rules governing opening of draws..... 1, 581
 Stone Bridge, Sakonnet River, R. I., alteration of 1, 113, 898
 Yellowstone National Park, construction, etc., of 1, 604; IV, 3033
- Bridgeton and Millville Traction Company, bridge of..... 1, 586
- Broad Creek, Va., bridge across..... 1, 587
- Broad Creek River, Del., improvement of..... 1, 202; II, 1079
- Broad Sound, Boston Harbor, Mass., improvement of..... 1, 98, 871
- Bronx River, N. Y.:
 Improvement of..... 1, 154; II, 998
 Removal of wreck..... 1, 178; II, 1039

Canals, etc.—Continued.

- Barren River, Ky., lock and dam 1, 427; iii, 1988
 Bee Tree Shoals Canal, Ala. 1, 393; ii, 1712
 Benton Harbor Canal, Mich. (*see* St. Joseph Harbor) 1, 460; iii, 2141
 Big Barren River, Ky., lock and dam 1, 427; iii, 1988
 Big Sandy River, W. Va. and Ky., locks and dams ... 1, 417, 419; iii, 1946, 1952
 Big Stone Lake, Minn., reservoir dam 1, 381; ii, 1684
 Black River, La., locks and dams 1, 346, 354; ii, 1410, 1435
 Black Warrior River, locks and dams ... 1, 295, 300; ii, 1285, 1288, 1289, 1293, 1300
 Calaveras River, Cal., to Mormon channel, San Joaquin River 1, 529
 Canadian canal, St. Marys River, Ontario, commerce 1, 488; iii, 2217
 Cape Fear River above Wilmington, N. C., locks and dams ... 1, 233, 234; ii, 1142
 Cascades Canal, Columbia River, Oreg. 1, 547, 549; iii, 2377, 2378
 Chicago Drainage Canal, Ill. 1, 580
 Clubfoot and Harlowe Canal, N. C., waterway via 1, 231; ii, 1136
 Colbert Shoals Canal, Ala. 1, 393; ii, 1712
 Columbia River, Cascades Canal 1, 547, 549; iii, 2377, 2378
 Columbia River, The Dalles Rapids to Celilo Falls, locks and dams. 1, 546; iii, 2376
 Congaree River, S. C., lock and dam 1, 245; ii, 1163
 Coosa River, Ga. and Ala., locks and dams ... 1, 291, 292, 293; ii, 1274, 1276, 1277
 Courtableau Bayou, La., lock and dam 1, 322; ii, 1340
 Cumberland River, Tenn. and Ky., locks and dams ... 1, 388, 390; ii, 1695, 1699
 Davis Island dam, Ohio River, Pa. 1, 407; iii, 1897
 Des Moines Rapids Canal, Mississippi River 1, 371; ii, 1651
 Dismal Swamp Canal, Va. and N. C., waterway via 1, 223; ii, 1120
 Duluth Canal, Minn., improvement of 1, 430; iii, 2005
 Edisto, South, River to Ashpoo River, S. C. (*see* Charleston-Beaufort waterway) 1, 249; ii, 1171
 Estherville-Minim Creek Canal, S. C. (*see* Santee River) 1, 242; ii, 1160
 Fox River, Wis., locks and dams 1, 449, 451; iii, 2077, 2080
 Galena River, Ill., lock and dam 1, 372; ii, 1658
 Galveston and Brazos Canal, Tex., purchase of 1, 337; ii, 1379
 Gowanus Canal, New York Harbor, N. Y. (*see* Gowanus Bay) 1, 148, 974
 Grand Rapids, Wabash River, lock and dam 1, 425, 426; iii, 1984, 1985
 Great Kanawha River, W. Va., locks and dams 1, 413, 414; iii, 1927, 1928
 Green River, Ky., locks and dams 1, 427; iii, 1988
 Herr Island, Allegheny River, Pa., lock and dam 1, 408; iii, 1900, 1901
 Illinois and Mississippi Canal, Ill., bridge across 1, 585
 Illinois and Mississippi Canal, Ill., construction of 1, 455; iii, 2118, 2121
 Illinois and Mississippi Canal, Ill., operating and care 1, 372; ii, 1656
 Illinois River, Ill., locks and dams 1, 454, 455; iii, 2113, 2115
 Kampsville lock and dam, Illinois River, Ill. 1, 455; iii, 2113, 2115
 Kanawha River, W. Va., locks and dams 1, 413, 414; iii, 1927, 1928
 Kentucky River, Ky., locks and dams 1, 419, 421; iii, 1953, 1955
 Keweenaw Point, Mich., canals across 1, 435, 436; iii, 2030
 Lagrange lock and dam, Illinois River, Ill. 1, 455; iii, 2113, 2115
 Levisa Fork, Big Sandy River, Ky., locks and dams 1, 417; iii, 1946
 Little Kanawha River, W. Va., lock and dam 1, 413; iii, 1925, 1926
 Louisville and Portland Canal, improvement and care. 1, 421, 424; iii, 1961, 1964, 1976
 Michigan Lake to Sturgeon Bay, improvement and care. 1, 441, 442; iii, 2049, 2054
 Minim Creek-Estherville Canal, S. C. (*see* Santee River) 1, 242; ii, 1160
 Mississippi River, Des Moines Rapids Canal 1, 371; ii, 1651
 Mississippi River to Illinois River, bridge across 1, 585
 Mississippi River to Illinois River, construction of 1, 455; iii, 2118, 2121
 Mississippi River to Illinois River, operating and care 1, 372; ii, 1656
 Mississippi River, reservoirs, construction of 1, 374; ii, 1672
 Mississippi River, reservoirs, operating and care 1, 375; ii, 1675
 Mississippi River, St. Paul to Minneapolis, locks and dams. 1, 373; ii, 1662, 1664
 Monongahela River, locks and dams 1, 401, 402, 404; iii, 1877, 1883, 1884
 Morgan Canal, Tex., improvement of (*see* Galveston ship channel). 1, 334; ii, 1374
 Morgan Canal, Tex., operating and care 1, 336; ii, 1377
 Mormon channel, San Joaquin River, Cal., to Calaveras River 1, 529
 Mosquito Creek Canal, S. C. (*see* Santee River) 1, 242; ii, 1160
 Muscle Shoals Canal, Ala. 1, 393, 395; ii, 1712, 1726
 Muskingum River, Ohio, locks and dams 1, 415, 416; iii, 1935, 1936
 Navigation of, rules governing 1, 580
 North Carolina Cut, N. C., improvement of waterway via 1, 224; ii, 1122
 North Menominee Canal, Milwaukee, Wis., bridge across 1, 588

- Cape Henry, Va., defenses at 1, 7
 Cape Porpoise Harbor, Me., improvement of 1, 79, 846
 Cape Vincent Harbor, N. Y., improvement of III, 2332
 Capitol, Washington, D. C., telegraph line to connect Executive Depart-
 ments and 1, 596; IV, 2717
 Carleton, P. J. (barge); removal of wreck of 1, 151, 982
 Carquines Strait, Cal., channel to the Golden Gate (*see* San Pablo Bay) 1, 527
 Carrabelle bar and harbor, Fla., improvement of 1, 282; II, 1253
 Carriages, gun and mortar 1, 8, 9
 Carters Creek, Va.:
 Improvement of 1, 207, 210
 Removal of wreck 1, 218; II, 1108
 Caruthersville Harbor, Mo. (*see* Mississippi River Commission) 1, 578; S., 3, 31
 Carvers Harbor, Me., improvement of 1, 72, 839
 Cascades Canal, Columbia River, Oreg.:
 Construction of 1, 547; III, 2377
 Operating and care 1, 549; III, 2378
 Casemates, mining 1, 8, 13
 Cedar Bayou, Tex., improvement of 1, 337, 338; II, 1379, 1383
 Centennial (barge), removal of wreck of 1, 226; II, 1126
 Centennial Lake, Miss. (*see* Vicksburg Harbor) 1, 350; II, 1420
 Central Railroad Company of New Jersey, bridge of 1, 589
 Ceres (bark), removal of wreck of 1, 273; II, 1216
 Champlain Lake, N. Y. and Vt.:
 Burlington Harbor, Vt., improvement of 1, 91, 860
 Defenses of 1, 7, 33, 759
 Narrows, improvement of 1, 94, 864
 Plattsburg Harbor, N. Y., improvement of 1, 93, 863
 Channels. *See* Rivers and harbors.
 Charletoi and Monessen Bridge Company, bridge of 1, 582
 Charles River, Mass. (*see* Boston Harbor) 1, 98, 871
 Charleston and Western Carolina Railway Company, bridge of 1, 591
 Charleston Harbor, S. C.:
 Defenses of 1, 7, 25, 723
 Improvement of 1, 247; II, 1166
 Improvement of waterway to Beaufort, S. C. 1, 249; II, 1171
 Improvement of waterway to McClellanville 1, 246; II, 1166
 Removal of logs from waterway to Beaufort, S. C. 1, 251; II, 1173
 Charleston (S. C.), Mining and Manufacturing Company, bridge of 1, 587
 Charlevoix Harbor, Mich., improvement of 1, 474; III, 2178
 Charlotte Harbor, Fla., improvement of 1, 274; II, 1218
 Charlotte Harbor, N. Y.:
 Improvement of 1, 515; III, 2323
 Water levels 1, 602; IV, 2763, 3032
 Charts:
 Military and other 1, 605, 611; IV, 3049
 Northern and Northwestern Lakes 1, 598; IV, 2763
 Chatham Harbor, Mass.:
 Improvement of 1, 107, 885
 Removal of wreck on Hardings Beach 1, 122, 911
 Chattahoochee River, Ga. and Ala.:
 Final report on survey between Westpoint and Franklin, Ga. 1, 293
 Improvement of, below Columbus, Ga. 1, 286; II, 1263
 Chaumont Harbor and River, N. Y., alteration of bridge 1, 590
 Cheboygan Harbor, Mich., improvement of 1, 477; III, 2183
 Chefuncte River, La., improvement of 1, 311, 312; II, 1318
 Chehalis River, Wash., improvement of 1, 564, 565; III, 2413
 Chelsea Creek, Mass. (*see* Boston Harbor) 1, 98, 871
 Chequamegon Bay, Wis. (*see* Ashland Harbor) 1, 433; III, 2027
 Chesapeake Bay, Md. and Va.:
 Defenses at entrance at Cape Henry, Va. 1, 7
 Defenses of Hampton Roads, Va. 1, 7, 23, 710
 Improvement of Cape Charles City Harbor, Va. 1, 222; II, 1118
 Improvement of Hampton Roads, Va. 1, 220; II, 1114
 Removal of wrecks in 1, 203; II, 1080
 Chester River, Md., improvement of 1, 195, 197; II, 1074
 Chester River, Pa., removal of wreck 1, 190; II, 1063

- Cohasset Harbor, Mass., improvement of 1, 104, 880
 Coldwater River, Miss., bridge in Quitman County 1, 585
 Collar, B. L. (barge), removal of wreck of 1, 178; II, 1039
 Colorado, department of the, reconnaissances and explorations... 1, 605, 610; IV, 3063
 Columbia River, Oreg. and Wash.:
 Cascades Canal, construction of 1, 547; III, 2377
 Cascades Canal, operating and care 1, 549; III, 2378
 Celilo, Oreg., improvement above 1, 544; III, 2375
 Celilo Falls to The Dalles Rapids, boat railway 1, 546; III, 2376
 Celilo Falls to The Dalles Rapids, locks and dams 1, 546; III, 2376
 Clark Fork (*see* Pend Oreille River) 1, 574; III, 2430, 2431
 Dredge for tributaries below the Willamette III, 2407
 Gauging 1, 561; III, 2408
 Mouth of, defenses at 7, 35, 781
 Mouth of, improvement at 1, 556; III, 2400
 Mouth of, to Willamette River, improvement from 1, 554; III, 2393
 Three-mile Rapids, improvement at 1, 546; III, 2376
 Tongue Point, Oreg., improvement below 1, 556; III, 2398
 Vancouver, Wash., to Willamette River, improvement from... 1, 549; III, 2383
 Comley, Ida E. (schooner), removal of wreck of 1, 203; II, 1080
 Commencement Bay, Wash.:
 Harbor lines at Tacoma 1, 579; III, 2432
 Improvement of Tacoma Harbor 1, 568; III, 2417
 Commercial statistics, Sault Ste. Marie canals, Mich 1, 488; III, 2217
 Compton Creek, N. J., improvement of 1, 165, 168; II, 1021
 Conecuh River, Ala., improvement of 1, 290; II, 1270
 Coney Island Creek, N. Y., alteration of West End Bridge 1, 590
 Congaree River, S. C.:
 Improvement of 1, 242, 244; II, 1163
 Improvement between Columbia and Granby 1, 245; II, 1163
 Congress, Fifty-seventh, first session, laws of, affecting Corps of Engineers. IV, 3079
 Conneaut Harbor, Ohio, improvement of 1, 508; III, 2290
 Connecticut River, Conn., improvement below Hartford 1, 126, 925
 Connecticut, State of, defenses of coast 1, 7, 19, 670
 Contentnia Creek, N. C., improvement of 1, 229; II, 1132
 Continuing contracts 1, 11, 61
 Albemarle Sound, N. C., waterway via 1, 223; II, 1120
 Allegheny River, Pa., locks and dams 1, 408; III, 1900
 Ambrose Channel, New York Harbor, N. Y. 1, 146, 969
 Appomattox River, Va 1, 222; II, 1117
 Arthur Kill, N. Y. and N. J 1, 162; II, 1012
 Ashtabula Harbor, Ohio 1, 503; III, 2283
 Back Cove, Portland, Me 1, 76, 842
 Baltimore Harbor, Md., channel to Curtis Bay 1, 194; II, 1070
 Baltimore Harbor, Md., Patapsco River and channel to 1, 192; II, 1067
 Baltimore Harbor, Md., at Spring Garden 1, 194; II, 1071
 Bay Ridge Channel, New York Harbor, N. Y 1, 148, 974
 Bee Tree Shoals, Tennessee River, Ala 1, 393; II, 1712
 Big Sandy River, W. Va. and Ky., including the forks 1, 417; III, 1946
 Biscayne Bay, Fla 1, 271; II, 1212
 Black River, La 1, 346; II, 1410
 Black River (Lorain) Harbor, Ohio 1, 499; III, 2264
 Black Rock Harbor, Buffalo, N. Y., Lake Erie entrance 1, 511
 Black Warrior River, Ala., above Tuscaloosa 1, 295; II, 1285
 Black Warrior River, Ala., below Tuscaloosa 1, 296; II, 1289, 1290
 Boston Harbor, Mass 1, 98, 871
 Bridgeport Harbor, Conn 1, 133, 937
 Buffalo Bayou, Tex 1, 334; II, 1374
 Buffalo Harbor, N. Y 1, 509; III, 2300
 Buffalo Harbor, N. Y., Lake Erie entrance to Erie Basin and Black
 Rock Harbor 1, 511
 Calumet Harbor, Ill 1, 453; III, 2101
 Cape Porpoise Harbor, Me 1, 79, 846
 Charleston Harbor, S. C 1, 247; II, 1166
 Chicago River, Ill 1, 452; III, 2097
 Christiana River, Del 1, 185; II, 1053
 Cleveland Harbor, Ohio 1, 500; III, 2269

Continuing contracts—Continued.

New Haven Harbor, Conn	i, 128, 930
New London Harbor, Conn	i, 124, 923
New York Harbor, N. Y., Ambrose Channel	i, 146, 969
New York Harbor, N. Y., Gowanus Bay channels	i, 148, 974
Norfolk Harbor, Va., Hospital Point	i, 219; ii, 1111
Norfolk Harbor, Va., waterway to sounds of North Carolina	i, 223; ii, 1120
Northern and Northwestern Lakes, channels connecting	i, 485; iii, 2197
Oakland Harbor, Cal	i, 527; iii, 2349
Ocmulgee River, Ga	i, 259; ii, 1191
Ohio River, Dams Nos. 2-5, 8 and 11	i, 410; iii, 1919
Ohio River, Dam No. 37	i, 399; ii, 1864
Ohio River, Falls of, at Louisville, Ky	i, 421; iii, 1961
Ouachita River, Ark. and La.	i, 346; ii, 1410
Pamlico Sound, N. C., waterway to Norfolk Harbor, Va	i, 223; ii, 1120
Pascagoula River, Miss., below mouth of Dog River	i, 301; ii, 1305
Pasquotank River, N. C., waterway via	i, 223; ii, 1120
Passaic River, N. J	i, 161; ii, 1010
Pass a Loutre, Mississippi River, sill across	i, 315; ii, 1323
Patapsco River, Md., and channel to Baltimore	i, 192; ii, 1067
Patapsco River, Md., channel to Curtis Bay	i, 194; ii, 1070
Patapsco River, Md., harbor of Southwest Baltimore (Spring Garden)	i, 194; ii, 1071
Pedee River, S. C	i, 239; ii, 1152
Plaquemine Bayou, La.	i, 319; ii, 1334
Portage Lake, Manistee County, Mich., harbor of refuge	i, 472; iii, 2174
Portland Harbor, Me., including Back Cove	i, 76, 842
Potomac River below Washington, D. C	i, 205; ii, 1085
Providence River, R. I.	i, 115, 900
Red Hook Channel, New York Harbor, N. Y	i, 148, 974
Rockland Harbor, Me	i, 71, 837
Sacramento River, Cal	i, 530; iii, 2355
St. Johns River, Fla., Jacksonville to the ocean	i, 265; ii, 1201
St. Joseph Harbor, Mich	i, 480; iii, 2141
St. Marys River, Mich., at the falls	i, 487; iii, 2201
St. Marys River, Mich., Hay Lake and Neebish channels	i, 489; iii, 2228
Sandbeach harbor of refuge, Mich	i, 480; iii, 2189
San Diego Harbor, Cal	i, 521; iii, 2341
San Francisco Harbor, Cal	i, 528; iii, 2348
San Joaquin River, Cal., Stockton and Mormon channels	i, 529
San Pablo Bay, Cal	i, 527
San Pedro Bay, Cal	i, 522; iii, 2342
Saugatuck Harbor, Mich	i, 462; iii, 2149
Savannah Harbor, Ga	i, 251; ii, 1177
Savannah River, Ga., between Augusta and Savannah	i, 253; ii, 1182
Seacoast defenses	i, 11
Ship channel connecting waters of the Great Lakes	i, 485; iii, 2197
Ship Island Harbor, Miss., channel to Gulfport	i, 306; ii, 1312
South Chicago Harbor, Ill. (<i>see</i> Calumet Harbor)	i, 453; iii, 2101
Southwest Baltimore Harbor, Md., at Spring Garden	i, 194; ii, 1071
Southwest Pass, Mississippi River	i, 315; ii, 1173, 1323
Spring Garden, Southwest Baltimore Harbor, Md	i, 194; ii, 1071
Staten Island Sound, N. Y. and N. J	i, 162; ii, 1012
Stockton channel, San Joaquin River, Cal	i, 529
Sturgeon Bay Canal, Wis., including harbor of refuge	i, 441; iii, 2049
Superior Harbor, Wis	i, 430; iii, 2005
Superior Lake to Keweenaw Bay, Mich., waterway	i, 435; iii, 2030
Tacoma Harbor, Wash	i, 568; iii, 2417
Tennessee River, Ala., Colbert and Bee Tree shoals	i, 393; ii, 1712
Tampa Bay, Fla	i, 275; ii, 1219
Toledo Harbor, Ohio	i, 494; iii, 2249
Tombigbee River, Ala., at Demopolis	i, 295, 296; ii, 1289, 1290
Trinity River, Tex., locks and dams	i, 336; ii, 1378
Tug Fork, Big Sandy River, W. Va. and Ky	i, 417; iii, 1946
Turners Cut, N. C., waterway via	i, 223; ii, 1120
Union River, Me	i, 66, 831
Vicksburg Harbor, Miss	i, 350; ii, 1420

- Currituck County, N. C., bridge of i, 580
 Currituck Sound, N. C., improvement of waterway via i, 224; ii, 1122
 Curtis Bay, Baltimore, Md., improvement of channel to i, 194; ii, 1070
 Cut-off, Apalachicola River, Fla., improvement of i, 284; ii, 1257
 Cuyahoga River, Ohio:
 Improvement of Cleveland Harbor i, 500; iii, 2269
 Rebuilding of Middle Seneca Street Bridge at Cleveland i, 586
 Cypress Bayou, Tex. and La., improvement of i, 346; ii, 1409
 Cypress Lake, Fla (*see* Kissimmee River) i, 274, 282; ii, 1217, 1225, 1239

D.

- Daisy (bugeye), removal of wreck of, Carters Creek, Va. i, 218; ii, 1108
 Daisy (flatboat), removal of wreck of, Buffalo Bayou, Tex i, 342; ii, 1391
 Dalecarlia Reservoir, Washington Aqueduct, D. C. i, 593; iv, 2691
 Dams. *See* Canals and Waterways.
 D'Arbonne Bayou, La.:
 Improvement of i, 347, 350
 Survey of (*see* Ouachita and Black rivers) i, 354; ii, 1435
 Darien Harbor, Ga., improvement of i, 256; ii, 1185
 Dartmouth, Mass., bridge of city of i, 585
 Davis Island dam, Ohio River, Pa., operating and care i, 407; iii, 1897
 Débris, mining, in California i, 577; iii, 2443
 Deep Creek Branch, Elizabeth River, Va., improvement of waterway
 via i, 223; ii, 1120
 Defenses, seacoast. *See* Fortifications.
 Delaware Bay and River, N. J., Pa., and Del.:
 Defenses of i, 7, 21, 694
 Delaware breakwater, Del., maintenance and repair of i, 176; ii, 1035
 Harbor of refuge in bay, construction of i, 176; ii, 1036
 Improvement of river i, 172; ii, 1025
 League Island navy-yard, harbor lines at i, 579; ii, 1041
 Lewes, Del., iron pier near, maintenance and repair of i, 175; ii, 1035
 Marcus Hook, Pa., improvement of ice harbor i, 178; ii, 1045
 Waterway to Chincoteague Bay, Va., improvement of i, 188; ii, 1060
 Wrecks, removal of i, 178; ii, 1039, 1040
 Delaware Breakwater Harbor, Del.:
 Maintenance and repair of breakwater i, 176; ii, 1035
 Removal of wreck i, 178; ii, 1039
 Delray, Mich., bridge across Rouge River i, 589
 Delta Point, La. (*see* Mississippi River Commission) i, 578; S., 3, 31
 Dennis Creek, N. J., removal of wreck i, 190; ii, 1063
 Departments, Executive, Washington, D. C., telegraph line connecting i, 596; iv, 2717
 Departments, military, reconnaissances and explorations i, 605; iv, 3049
 Depot, Engineer i, 41, 42, 807, 817
 Derelicts. *See* Wrecks.
 Des Moines Rapids Canal and dry dock, Mississippi River, operating and
 care i, 371; ii, 1651
 Details, technical, of engineering methods. *See* Technical details.
 Detroit River, Mich.:
 Defenses of i, 33, 759
 Improvement of i, 492; iii, 2235
 Improvement of channels in waters connecting Great Lakes i, 485; iii, 2197
 Survey from Detroit to Lake Erie, final report on i, 494
 Surveys, etc. (*see* Northern and Northwestern Lakes) i, 598; iv, 2763
 Disappearing carriages i, 8, 9
 Discharge measurements. *See* Gauging.
 Dismal Swamp Canal, Va. and N. C., improvement of waterway via i, 223; ii, 1120
 District of Columbia. *See* Washington.
 Dividing Creek (La Trappe River), Md., improvement of i, 200; ii, 1078
 Dividing Creek, N. J., bridge across, at town of Dividing Creek i, 591
 Division, engineers i, 62
 Divisions, engineer i, 62
 Divisions, military, reconnaissances and explorations i, 605; iv, 3049
 Doboy Bar, Ga., improvement of i, 256; ii, 1186
 Dock lines. *See* Harbor lines.
 Double Bayou, Tex., improvement of i, 337; ii, 1379

- Echo Bay Harbor, N. Y., improvement of 1, 146
 Edenton Bay, N. C., improvement of 1, 225; II, 1124
 Edgewater, N. J., removal of wreck to 1, 151, 982
 Edisto, South, River, S. C., waterway via 1, 249; II, 1171
 Eel River, Mass. (*see* Plymouth Harbor) 1, 106, 882
 Eighteen-mile Creek, N. Y. (*see* Olcott Harbor) 1, 514; III, 2322
 Eldridge (schooner), removal of wreck of 1, 203; II, 1080
 Electrical connections at fortifications 1, 14, 38
 Elizabeth City, N. C., harbor lines in Pasquotank River 1, 579; II, 1127
 Elizabeth Park and Land Company, bridge of 1, 587
 Elizabethport, N. J., bridge across Newark Bay to Bayonne 1, 589
 Elizabeth River, N. J., improvement of 1, 165, 168; II, 1020
 Elizabeth River, Va.:
 Bridge across Western Branch 1, 587
 Improvement of Norfolk Harbor and its approaches 1, 219; II, 1111
 Improvement of waterway to Albemarle Sound, via Currituck
 Sound 1, 224; II, 1122
 Improvement of waterway to sounds of North Carolina, via Pasquotank
 River 1, 223; II, 1120
 Improvement of Western Branch 1, 220; II, 1113
 Removal of wrecks in Southern Branch 1, 226; II, 1126
 Elkpoin, S. Dak. (*see* Missouri River) 1, 383; II, 1687
 Elk River, Md., improvement of 1, 191; II, 1066
 Elk River, W. Va.:
 Bridge near mouth of Big Otter Creek 1, 587
 Improvement of 1, 415; III, 1933
 Elliott Bay, Wash., bridge across waterway between Duwamish River and 1, 590
 Ellis Island, New York Harbor, N. Y., harbor lines 1, 579, 988
 Embankments 1, 12, 38
 Emplacements 1, 9, 10
 Employees as civilian assistants to engineer officers 1, 38
 Endicott Board 1, 6
 Engineer Depot 1, 41, 42, 807, 817
 Engineer divisions 1, 62
 Engineer equipment of troops 1, 38, 44, 811, 814, 818
 Engineering methods, technical details of. *See* Technical details.
 Engineer officers, civilian assistants to 1, 38
 Engineers, Battalions of 1, 38, 40, 42, 44, 607, 802, 811, 814, 818, IV, 3054
 Engineers, Chief of, officers on duty in Office of the 1, 612
 Engineer School of Application, U. S. Army 1, 39, 796
 Engineers, Corps of:
 Battalions of Engineers 1, 38, 40, 42, 44, 607, 802, 811, 814, 818; IV, 3054
 Changes in personnel 1, 3
 Engineer equipment of troops and civilian assistants to engineer offi-
 cers 1, 38, 44, 811, 814, 818
 Laws of Fifty-seventh Congress, first session, affecting the IV, 3079
 Number and distribution of officers 1, 3
 Officers on duty in Office of the Chief of Engineers 1, 612
 Service of officers abroad and in the field, with troops 1, 45
 Engineers, division 1, 62
 Engineers, The Board of 1, 6, 7, 615
 Engineer troops. *See* Troops.
 Equipment, engineer, of troops 1, 38, 44, 811, 814, 818
 Erie Basin, Buffalo, N. Y.:
 Improvement of Buffalo entrance to 1, 511; III, 2313
 Improvement of Lake Erie entrance to 1, 511
 Erie Harbor, Pa.:
 Improvement of 1, 507; III, 2295
 Water levels 1, 602; IV, 2763, 3032
 Erie Lake:
 See also Northern and Northwestern Lakes.
 Removal of wrecks 1, 506; III, 2293, 2294
 Water levels 1, 602; IV, 2763, 3032
 Escambia River, Fla., improvement of 1, 290; II, 1270
 Escanaba, Mich., water levels 1, 602; IV, 2763, 3032
 Esopus Creek, N. Y. (*see* Saugerties Harbor) 1, 141, 954
 Essex County, Mass., bridge of 1, 586

- Florida East Coast Railway Company, construction of basin at Miami, Fla.,
by..... i, 271; ii, 1212
- Flushing Bay, N. Y., improvement of i, 156, 158; ii, 1005
- Foothridge across Potomac River at Washington, D. C., to replace Long
Bridge i, 592; iv, 2652
- Foreign possessions. *See* Insular possessions.
- Fore River, Mass. *See* Weymouth River.
- Forked Deer River, Tenn., improvement of..... i, 386, 387; ii, 1693
- Fortifications:
See also Technical details.
- Appropriations required for 1903-4, estimates of i, 38
 - Board of Engineers, The i, 6, 7, 615
 - Board of Ordnance and Fortification i, 6
 - Board on Fortifications or other Defenses (Endicott Board) i, 6
 - Board on Torpedo System i, 6
 - Carriages, gun and mortar i, 8, 9
 - Continuing contracts i, 11
 - Dynamite batteries i, 11
 - General statement, and progress of work i, 6
 - Gun and mortar batteries i, 6, 8, 38
 - Insular possessions i, 7, 37, 791
 - Preservation and repair of i, 12, 38
 - Projects i, 7
 - Range and position finders i, 11, 38
 - Searchlights and electrical connections i, 14, 38
 - Sea walls and embankments i, 12, 38
 - Sites i, 13, 38
 - Submarine mines i, 13
 - Supplies for seacoast defenses i, 12, 38
- Fort Pierre, S. Dak. (*see* Missouri River)..... i, 382; ii, 1687
- Fort Point Channel, Boston, Mass.:
Improvement of..... i, 98, 871
- Rebuilding of Broadway Bridge..... i, 587
 - Rebuilding of Cove Street Bridge..... i, 588
- Fort Totten, N. Y., Engineer Depot and engineer troops i, 42, 802, 807, 817
- Fort Washakie, Wyo., road to Buffalo Fork, Snake River..... i, 612; iv, 3075
- Fourteen Foot Bank light-house, Delaware Bay, removal of wreck near. i, 178; ii, 1040
- Fowler, Lida (schooner), removal of wreck of..... i, 178; ii, 1040
- Fox River, Wis.:
Bridge at Green Bay i, 588
- Improvement of i, 449; iii, 2077
 - Improvement of Green Bay Harbor..... i, 440; iii, 2047
 - Operating and care of locks and dams i, 451; iii, 2080
- Frankfort Harbor, Mich., improvement of i, 473; iii, 2176
- Fremont, Wash., bridge across Puget Sound-Lake Washington Canal i, 588
- French Broad River, Tenn., improvement of i, 395; ii, 1739
- Friend, Lottie K. (schooner), removal of wreck of..... i, 178; ii, 1039

G.

- Galena River, Ill., operating and care of lock and dam..... i, 372; ii, 1658
- Gallipolis, Ohio, ice pier (*see* Ohio River) i, 399; ii, 1842
- Galveston and Brazos Canal, Tex., purchase of i, 337; ii, 1379
- Galveston Bay and Harbor, Tex.:
Defenses of..... i, 7, 30, 752
- Examination and survey of inner harbor i, 343; ii, 1392, 1395
 - Improvement of Galveston-Texas City channel i, 334; ii, 1372
 - Improvement of harbor..... i, 332; ii, 1356
 - Improvement of harbor from inner bar to Fifty-first street i, 334; ii, 1371
 - Improvement of waterway to Houston i, 334; ii, 1374
 - Improvement of West Bay i, 337, 338; ii, 1379, 1384
 - Removal of wrecks i, 342; ii, 1390, 1391
- Gasconade River, Mo.:
Bridge across..... i, 583
- Improvement by Missouri River Commission i, 579; ii, 181, 213

- Great Salt Pond, Block Island, R. I., improvement of i, 121, 909
 Great Sodus Bay, N. Y., improvement of harbor i, 516; iii, 2325
 Great South Bay, N. Y. (*see* Patchogue River) i, 160; ii, 1009
 Green Bay, Mich., water levels at Escanaba i, 602; iv, 2763, 3032
 Green Bay Harbor, Fox River, Wis.:
 Construction of bridge i, 588
 Improvement of i, 440; iii, 2047
 Greene County, Miss.:
 Bridge of, across Chickasahay River i, 588
 Bridge of, across Leaf River i, 588
 Green Jacket Shoal, Providence River, R. I., removal of i, 115, 116, 902
 Greenleaf Bend, Mississippi River, Ill., prevention of break into Cache
 River i, 369; ii, 1606
 Green River, Ky.:
 Improvement above mouth of Big Barren River i, 427; iii, 1988
 Operating and care of locks and dams i, 427; iii, 1988
 Greenville Harbor, Miss. (*see* Mississippi River Commission) i, 578; S., 3, 31
 Greenwich Harbor, Conn., improvement of i, 137, 139, 944
 Grounds, public buildings and, District of Columbia i, 596; iv, 2717
 Guam Island, defenses of i, 7
 Gulf, Colorado and Santa Fe Railway Company, bridge of i, 583
 Gulfport, Miss., improvement of channel to Ship Island Harbor i, 306; ii, 1312
 Gulf States:
 Removal of water hyacinths from Florida waters i, 272; ii, 1215
 Removal of water hyacinths from Louisiana waters i, 327; ii, 1347
 Removal of water hyacinths from Texas waters i, 272, 327
 Guns:
 Batteries i, 6, 8, 38
 Carriages i, 8
 Guyandot River, W. Va., improvement of i, 417; iii, 1945

H.

- Hackensack River, N. J., bridge at Little Ferry i, 584
 Hallsville, N. C., removal of wreck in Northeast River i, 237
 Hampton Roads, Va.:
 Defenses of i, 7, 23, 710
 Improvement of i, 220; ii, 1114
 Improvement of approaches to Norfolk Harbor i, 219; ii, 1111
 Hancock, Mich., bridge across Portage Lake i, 582
 Harbor lines, establishment of i, 579
 Adams Island, Hudson River, Troy, N. Y. i, 579, 961
 Alexandria Bay, St. Lawrence River, N. Y. i, 579; iii, 2338
 Atlantic Basin, Buttermilk Channel, Brooklyn, N. Y. i, 579, 983
 Boston, Mass. i, 579, 887
 Bowery Bay, East River, N. Y. i, 579, 964
 Brooklyn, N. Y., Buttermilk Channel at Atlantic Basin i, 579, 983
 Brooklyn, N. Y., navy-yard, East River at Cob Dock i, 579, 966
 Buttermilk Channel, New York Harbor, N. Y. i, 579, 983
 Chicago River, Ill., North Branch, at Chicago i, 579; iii, 2110
 Cob Dock, East River, Brooklyn navy-yard, N. Y. i, 579, 966
 Commencement Bay, Wash. i, 579; iii, 2432
 Delaware River, Pa., at League Island navy-yard i, 579; ii, 1041
 East River, N. Y., at Cob Dock, Brooklyn navy-yard i, 579, 966
 East River, N. Y., in Bowery Bay at Steinway i, 579, 964
 Elizabeth City, N. C. i, 579; ii, 1127
 Ellis Island, New York Harbor, N. Y. i, 579, 988
 Gowanus Bay, N. Y., Buttermilk Channel i, 579, 983
 Homestead Bridge, Pa., to McKeesport i, 579; iii, 1912
 Hudson River, N. Y., at New Baltimore i, 579, 962
 Hudson River, N. Y., at Troy i, 579, 961
 Kansas City, Mo. and Kans. i, 579; S., 213
 Kill van Kull, at Shooters Island i, 579, 986
 Lavaca Bay, Tex. i, 579; ii, 1402
 League Island navy-yard, Delaware River, Pa. i, 579; ii, 1041
 McKeesport, Pa., to Homestead Bridge i, 579; iii, 1912
 Missouri River, Kansas City, Mo. and Kans. i, 579; S., 213

- Hospital Point, Norfolk Harbor, Va., removal of i, 219; ii, 1111
 Houghton County, Mich., bridge of i, 582
 Houghton, Mich., bridge across Portage Lake to Hancock i, 582
 Housatonic River, Conn., improvement of i, 132, 934
 Houston, Tex., improvement of waterway to Galveston i, 334; ii, 1374
 Howard University Reservoir, Washington, D. C. i, 594; iv, 2706
 Hudson River, N. Y.:
 Improvement of i, 140, 947
 New Baltimore, harbor lines i, 579, 962
 Peekskill Bay, bridge near Peekskill i, 588
 Peekskill Harbor, improvement of i, 141, 142, 956
 Rondout Harbor, improvement of i, 141, 955
 Saugerties Harbor, improvement of i, 141, 954
 Troy, harbor lines i, 579, 961
 Humboldt Harbor and Bay, Cal., improvement of i, 533; iii, 2360
 Huntington Harbor, N. Y., improvement of i, 156, 157; ii, 1003
 Huron Harbor, Ohio, improvement of i, 498; iii, 2260
 Huron Lake:
 See also Northern and Northwestern Lakes.
 Final report on survey of waterway to Lake Superior i, 494
 Improvement of harbor of refuge at Sandbeach, Mich. i, 480; iii, 2189
 Water levels i, 602; iv, 2763, 3032
 Hyacinths, water:
 Removal of, from Florida waters i, 272; ii, 1215
 Removal of, from Louisiana waters i, 327; ii, 1347
 Removal of, from Texas waters i, 272, 327
 Hyannis, Mass., improvement of harbor of refuge i, 108, 890
 Hydraulic mining in California i, 577; iii, 2443
 Hydraulics. *See* Gauging and Technical details.

I.

- Iberia and Vermilion Railroad Company, bridge across Bayou Vermilion,
 La i, 584
 Illinois and Mississippi Canal, Ill.:
 Bridge in Bureau County i, 585
 Construction of, with revised estimate of cost of completion. i, 455; iii, 2118, 2121
 Operating and care i, 372; ii, 1656
 Illinois River, Ill.:
 Improvement of i, 454; iii, 2113
 Operating and care of locks and dams i, 455; iii, 2115
 Index (schooner), removal of wreck of i, 95, 865
 Indiana Chute, Falls of Ohio River, improvement of, with plan for complet-
 ing project i, 421; iii, 1961, 1964
 Indianapolis, Ind., bridge across White River i, 588
 Indian River, Fla., improvement of i, 269; ii, 1210
 Indian River Bay, Del., waterway via i, 188; ii, 1060
 Indian River Inlet, Fla. (*see* Indian River) i, 269; ii, 1210
 India Point, Pawtucket River, R. I., bridge at i, 587
 Individuals, improvement of navigable waters by i, 61; iv, 2567
 Inland waterways. *See* Canals and Waterways.
 Inlets. *See* Rivers and harbors.
 Inner harbors. *See* Rivers and harbors.
 Inside routes. *See* Canals and Waterways.
 Insular possessions:
 Defenses of i, 7, 37, 791
 Improvement of Manila Harbor and Pasig River i, 606; iv, 3055
 Improvement of Pearl Harbor, Hawaii i, 534; iii, 2361
 Reconnaissances and explorations in i, 605; iv, 3050, 3062
 Ironton, Ohio, ice harbor (*see* Ohio River) i, 399; ii, 1842
 Island possessions. *See* Insular possessions.
 Isle of Wight Bay, Md., improvement of waterway via i, 188; ii, 1060
 Isles of Shoals, Me., improvement of harbor at i, 79, 847
 Istokpoga Creek, Fla. (*see* Kissimmee River) i, 274, 282; ii, 1217, 1225, 1239

- Kingston Station, N. Y., bridge across Rondout Creek..... 1, 586
 Kinnickinnick River, Wis. (*see* Milwaukee Harbor)..... 1, 446; III, 2067
 Kissimmee Lake and River, Fla.:
 Examination and survey..... 1, 282; II, 1225, 1239
 Improvement of..... 1, 274; II, 1217
 Kissimmee (steamer), removal of wreck of..... 1, 281; II, 1225
 Knights Landing, Sacramento River, Cal., bridge at..... 1, 586
 Kootenai River, Idaho, improvement between Bonners Ferry and international boundary..... 1, 575; III, 2431

L.

- La Crosse Harbor, Wis., improvement of..... 1, 372; II, 1660
 Laffrinier, Ira (schooner), removal of wreck of..... 1, 108, 886
 Lafourche Bayou, La., improvement of..... 1, 318; II, 1332
 Lagrange Bayou, Fla., improvement of..... 1, 288; II, 1267
 Lagrange lock and dam, Illinois River, Ill., operating and care..... 1, 455; III, 2115
 Lakes, department of the, reconnaissances and explorations.... 1, 605, 606; IV, 3049
 Lakes, Great. *See* Great Lakes.
 Lamprey River, N. H. (*see* Cocheco River)..... 1, 80, 848
 L'Anguille River, Ark., improvement of..... 1, 363, 364; II, 1590
 Laporte County, Ind., bridge of..... 1, 584
 Larchmont Harbor, N. Y., improvement of..... 1, 153; II, 996
 La Trappe River, Md., improvement of..... 1, 200; II, 1078
 Lavaca Bay, Tex., harbor lines at Port Lavaca..... 1, 579; II, 1402
 Laws of Fifty-seventh Congress, first session, affecting Corps of Engineers... IV, 3079
 Leaf River, Miss.:
 Bridge near Atkinsons Creek or Cochrans Ferry..... 1, 588
 Improvement of..... 1, 303, 305; II, 1311
 League Island navy-yard, Pa., harbor lines in Delaware River..... 1, 579; II, 1041
 Leakesville, Miss., bridge across Chickasahay River..... 1, 588
 Leech Lake, Minn.:
 Construction of reservoir dam..... 1, 374; II, 1672
 Operating and care of reservoir dam..... 1, 375; II, 1675
 Legislation of Fifty-seventh Congress, first session, affecting Corps of Engineers..... IV, 3079
 Lehman, R. B., contract with State of Washington (*see* Tacoma Harbor) 1, 568; III, 2417
 Lemon Creek, N. Y. (*see* Staten Island-New Jersey channel)..... 1, 162; II, 1012
 Levels, water. *See* Water-level observations.
 Levisa Fork, Big Sandy River, Ky., improvement of..... 1, 417; III, 1946
 Lewes, Del.:
 Improvement of waterway to Chincoteague Bay, Va..... 1, 188; II, 1060
 Iron pier in Delaware Bay near, maintenance and repair of..... 1, 175; II, 1035
 Lewis River, Wash.:
 Bridge across..... 1, 585
 Improvement of..... 1, 559, 560; III, 2406, 2407
 Liberty County, Tex., bridge across Trinity River in..... 1, 583
 Lichtenfels Bros. (barge), removal of wreck of..... 1, 151, 982
 Lighter No. 33, removal of wreck of, from Schuylkill River..... 1, 190; II, 1063
 Lincoln, Abraham, bronze tablet to..... 1, 596; IV, 2717
 Little Assawaman Bay, Del., waterway via..... 1, 188; II, 1060
 Little D'Arbonne Bayou, La. (*see* D'Arbonne)..... 1, 350
 Little Ferry, N. J.:
 Bridge across Hackensack River at..... 1, 584
 Bridge across Overpeck Creek at..... 1, 587
 Little Harbor, N. H., improvement of harbor of refuge..... 1, 81, 850
 Little Kanawha River, W. Va.:
 Improvement of..... 1, 413; III, 1925
 Operating and care of lock and dam..... 1, 413; III, 1926
 Little Mud River, Ga., improvement of waterway via..... 1, 262; II, 1196
 Little Narragansett Bay, R. I. and Conn. (*see* Pawcatuck River)..... 1, 123, 921
 Little Pedee River, S. C., improvement of..... 1, 237, 238; II, 1151
 Little Pigeon River, Tenn., improvement of..... 1, 395, 396; II, 1739
 Little River, La. (*see* Red River)..... 1, 343; II, 1405
 Little Sodus Bay, N. Y., improvement of harbor..... 1, 516; III, 2327
 Little Tallahatchie River, Miss. (*see* Tallahatchie)..... 1, 352; II, 1432
 Locks. *See* Canals and Waterways.
 Logs, loose, rules governing floating of, on certain streams..... 1, 580

- Lone Tree Point, Cal. (*see* San Pablo Bay) 1, 527
 Long Bridge, Potomac River, Washington, D. C.:
 Highway bridge to replace 1, 582; IV, 2652
 Railroad bridge to replace 1, 582
 Long Island Sound, N. Y., defenses of eastern entrance 1, 7, 19, 670
 Long Sault Island, St. Lawrence River, N. Y., improvement at head of 1, 520; III, 2337
 Long Tom River, Oreg., improvement of 1, 551; III, 2387
 Lorain Harbor, Ohio, improvement of 1, 499; III, 2264
 Louisiana, removal of water hyacinths from waters in 1, 327; II, 1347
 Louisville and Nashville Railroad Company, bridge of 1, 581
 Louisville and Portland Canal, Ky.:
 Enlargement of, with plan for completing project 1, 421; III, 1961, 1964
 Operating and care 1, 424; III, 1976
 Loutre, Pass a, Mississippi River, La.:
 Closing crevasse in 1, 314; II, 1322
 Constructing sill across 1, 315; II, 1323
 Lower Machodoc Creek, Va., improvement of 1, 207, 209; II, 1091
 Lubec Channel, Me., improvement of 1, 62, 827
 Ludington Harbor, Mich., improvement of 1, 470; III, 2168
 Lumberton Branch, Rancocas River, N. J., improvement of 1, 179; II, 1046
 Luzon, Northern and Southern, reconnaissances and explorations in depart-
 ments of 1, 607; IV, 3050
 Lynn Harbor, Mass., improvement of 1, 95, 867
 Lyttee, Ephraim (sloop), removal of wreck of 1, 203; II, 1080

M.

- McClellan statue, Washington, D. C. 1, 596; IV, 2717
 McClellanville, S. C., improvement of waterway to Charleston 1, 246; II, 1166
 McKeesport, Pa., harbor lines in Monongahela River to Homestead
 Bridge 1, 579; III, 1912
 Mackinac Straits, Mich., removal of wreck in 1, 494; III, 2244
 Maçon Bayou, La.:
 Improvement of 1, 347, 349; II, 1418
 Survey of (*see* Ouachita and Black rivers) 1, 354; II, 1435
 Macon, Dublin and Savannah Railroad Company, bridge of 1, 584
 Maggie (sloop), removal of wreck of 1, 203; II, 1080
 Mahon River, Del., removal of wreck 1, 190; II, 1063
 Maine, defenses of coast 1, 7, 14, 621
 Main Ship Channel, New York Harbor, N. Y.:
 Improvement of 1, 146, 969
 Removal of wreck 1, 151, 982
 Malden River, Mass., improvement of 1, 96, 869
 Mall, the, Washington, D. C. 1, 596; IV, 2717
 Mamaroneck Harbor, N. Y., improvement of 1, 152; II, 995
 Manasquan River, N. J., improvement of 1, 171; II, 1024
 Manatee River, Fla., improvement of 1, 278, 279; II, 1223
 Manchac Bayou, La., improvement of 1, 311, 313; II, 1321
 Manchester Harbor, Mass., improvement of 1, 90, 858
 Manila Harbor, Philippine Islands:
 Defenses of 1, 7
 Improvement of 1, 608; IV, 3055
 Manistee Harbor, Mich., improvement of 1, 471; III, 2171
 Manitowoc Harbor, Wis., improvement of 1, 444; III, 2062
 Manokin River, Md., improvement of 1, 202; II, 1079
 Mantua Creek, N. J., improvement of 1, 181; II, 1048
 Maps:
 Military and other 1, 605, 611; IV, 3049
 Northern and Northwestern Lakes 1, 598; IV, 2763
 Marblehead, Mass., repair of sea wall 1, 91, 860
 Marcushook, Pa., improvement of ice harbor 1, 178; II, 1045
 Marinette, Wis. (*see* Menominee River) 1, 439; III, 2043
 Marquette Bay and Harbor, Mich.:
 Construction of harbor of refuge in bay 1, 437; III, 2039
 Improvement of harbor 1, 436; III, 2037
 Water levels 1, 602; IV, 2763, 3032
 Marthas Vineyard, Mass., improvement of Vineyard Haven Harbor 1, 110, 893
 Mascot (steamer), removal of wreck of 1, 293; II, 1280

- Massachusetts, State of:
 Bridge of, across Mystic River 1, 589
 Defenses of southeast coast 1, 7, 18, 658
 Matanzas River, Fla. (*see* St. Augustine Harbor) 1, 269; II, 1208
 Matawan Creek, N. J., improvement of 1, 165, 166; II, 1016
 Mattaponi River, Va., improvement of 1, 214; II, 1098
 Mattituck Harbor, N. Y., improvement of 1, 155; II, 1000
 Maumee Bay and River, Ohio:
 Bridge across river near Toledo 1, 588
 Improvement of Toledo Harbor 1, 494; III, 2249
 Maumee Railway Bridge Company, bridge of 1, 588
 May, Ida (canal boat), removal of wreck of 1, 190; II, 1063
 Medford, Mass., bridge across Mystic River to Somerville 1, 589
 Melvina (schooner), removal of wreck of 1, 190; II, 1063
 Memorials, statues, etc.:
 In public grounds, Washington, D. C 1, 596; IV, 2717
 Memorial Bridge, Washington, D. C 1, 591; IV, 2652
 Tablet to Abraham Lincoln, Gettysburg Park, Pa 1, 596; IV, 2717
 Memphis Harbor, Tenn. (*see* Mississippi River Commission) 1, 578; S., 3, 31
 Menekaunee, Wis. (*see* Menominee River) 1, 439; III, 2043
 Menominee Harbor and River, Mich. and Wis., improvement of 1, 439; III, 2043
 Menominee River, Milwaukee, Wis. (*see* Milwaukee) 1, 446; III, 2067
 Mermentau River, La., improvement of, including tributaries ... 1, 323, 324; II, 1343
 Merrill, Miss., bridge across Pascagoula River 1, 585
 Merrimac, Wis., bridge across Wisconsin River 1, 585
 Merrimac River, Mass:
 Bridge between Newburyport and Salisbury 1, 586
 Improvement of 1, 84, 852
 Improvement of Newburyport Harbor 1, 82, 851
 Methods, engineering, technical details of. *See* Technical details.
 Mexico, Gulf of:
 Removal of water hyacinths from Florida tributaries 1, 272; II, 1215
 Removal of water hyacinths from Louisiana tributaries 1, 327; II, 1347
 Removal of water hyacinths from Texas tributaries 1, 272, 327
 Miami, Fla. (*see* Biscayne Bay) 1, 271; II, 1212
 Mianus River, Conn., improvement of 1, 139, 945
 Michigan Central Railroad Company, bridge of 1, 587
 Michigan City, Ind.:
 Bridge of Laporte County across Trail Creek 1, 584
 Bridge of Michigan Central Railroad Company across Trail Creek 1, 587
 Improvement of inner harbor 1, 457; III, 2137
 Improvement of outer harbor 1, 458; III, 2137
 Michigan Lake:
See also Northern and Northwestern Lakes.
 Canal to Sturgeon Bay, improvement of, including harbor of refuge. 1, 441; III, 2049
 Canal to Sturgeon Bay, operating and care 1, 442; III, 2054
 General remarks applicable to harbors on east shore III, 2135
 Water levels 1, 602; IV, 2763, 3032
 Water levels on east shore, variations in 1, 457
 Middleboro, Wareham and Buzzards Bay Street Railway Company, bridges of. 1, 583
 Middle Neebish Channel, St. Marys River, Mich., improvement of... 1, 489; III, 2228
 Middleport, Ohio, ice pier (*see* Ohio River) 1, 399; II, 1842
 Middlesex County, N. J.:
 Bridge of, across Raritan River 1, 589
 Bridge of, across Woodbridge Creek 1, 583
 Milan, Ill.:
 Construction of canal around Rock River at 1, 455; III, 2118
 Operating and care of canal around Rock River at 1, 372; II, 1656
 Milford Harbor, Conn., improvement of 1, 131, 934
 Milford Haven, Va., improvement of harbor at 1, 213; II, 1096
 Milgendutt (barge), removal of wreck of 1, 203; II, 1080
 Military reconnaissances and explorations 1, 605; IV, 3049
 Miller Bay, Lake Winnebago, Wis. (*see* Fox River) 1, 449; III, 2077
 Mill River, New Haven, Conn., improvement of 1, 128, 930
 Mill River, Stamford, Conn. (*see* Stamford) 1, 137, 138, 943
 Milwaukee Bay, Harbor, and River, Wis.:
 Bridge across North Menominee Canal at Muskego avenue 1, 588
 Bridge at Grand avenue 1, 585
 Improvement of 1, 446; III, 2067

Mississippi River—Continued.

- Snag and dredge boats above Missouri River, operation of..... 1, 370; II, 1609
- Snags and wrecks below Missouri River, removal of..... 1, 366; II, 1593
- South Pass, maintenance of channel 1, 316; II, 1324
- Southwest Pass, improvement of 1, 315; II, 1173, 1323
- Thebes, Ill., bridge to Grays Point, Mo 1, 582
- Vicksburg Harbor, Miss., improvement of 1, 350; II, 1420
- Vidalia, La. (*see* Mississippi River Commission)..... 1, 578; S., 3, 31
- Water-level observations on, including tributaries 1, 578; S., 3, 52
- Wrecks, etc., above Missouri River, removal of..... 1, 370; II, 1609
- Wrecks, etc., below Missouri River, removal of 1, 366; II, 1593
- Mississippi River Commission 1, 578; S., 3, 31
- Mississippi River, Hamburg and Western Railway Company, bridge of 1, 582
- Mississippi Sound, Miss.:
 - Defenses of..... 1, 29, 740
 - Improvement of Gulfport-Ship Island Harbor channel..... 1, 306; II, 1312
 - Improvement of Horn Island Harbor..... 1, 301; II, 1305
 - Improvement of Ship Island Pass 1, 307
- Missouri, department of the, reconnaissances and explorations.. 1, 605, 609; IV, 3060
- Missouri River:
 - Bridge at Plattsmouth, Nebr 1, 586
 - Harbor lines at Kansas City, Mo. and Kans 1, 579; S., 213
 - Improvement from Stubbs Ferry, Mont., to Sioux City, Iowa ... 1, 381; II, 1687
 - Improvement, surveys, etc., below Sioux City, Iowa 1, 579; S., 175, 194
 - Snagging upper river 1, 385; II, 1690
 - Missouri River Commission..... 1, 579; S., 175, 194
- Mobile Harbor, Ala.:
 - Defenses of..... 1, 7, 29, 740
 - Improvement of..... 1, 293; II, 1281
- Mobile, Jackson and Kansas City Railroad Company, bridge of..... 1, 585
- Moccasin River (Contentnia Creek), N. C., improvement of..... 1, 229; II, 1132
- Mokelumne River, Cal., improvement of..... 1, 529; III, 2354
- Mondego (schooner), removal of wreck of 1, 108, 886
- Monomoy light, Mass., removal of wreck on Stone Horse Shoal 1, 122, 911, 912
- Monongahela River, W. Va. and Pa.:
 - Bridge at Clairton Station..... 1, 582
 - Bridge between North Charleroi and Rostraver Township, Pa..... 1, 582
 - Bridge near Ferry street, Pittsburg 1, 581
 - Bridge at Try street, Pittsburg 1, 584
 - Bridge at Port Perry, Pa..... 1, 589
 - Construction of locks and dams between Morgantown and Fairmont, W. Va..... 1, 401; III, 1877
 - Harbor lines from Homestead Bridge to McKeesport, Pa..... 1, 579; III, 1912
 - Improvement at Locks Nos. 3 and 6 1, 402; III, 1883
 - Improvement of Pittsburg Harbor 1, 405; III, 1895
 - Operating and care of locks and dams..... 1, 404; III, 1884
- Monroe Harbor, Mich.:
 - Improvement of..... 1, 481, 482; III, 2247
 - Removal of wreck 1, 506; III, 2294
- Monroe Lake, St. Johns River, Fla. (*see* Volusia Bar) 1, 267; II, 1206
- Monuments, statues, etc.:
 - In public grounds, Washington, D. C..... 1, 596; IV, 2717
 - Memorial Bridge, Washington, D. C..... 1, 591; IV, 2652
 - Tablet to Abraham Lincoln, Gettysburg Park, Pa..... 1, 596; IV, 2717
- Morgan Canal, Tex.:
 - Improvement of (*see* Galveston ship channel) 1, 334; II, 1374
 - Operating and care 1, 336; II, 1377
- Mormon channel, San Joaquin River, Cal., improvement of..... 1, 529
- Morris and Essex Railroad Company, bridge of 1, 586
- Mortar batteries..... 1, 6, 8, 38
- Mosquito Creek Canal, S. C. (*see* Santee River)..... 1, 242; II, 1160
- Mound City, Ill. (*see* Ohio River) 1, 398; II, 1839
- Mount Desert, Bar Harbor, Me., construction of breakwater..... 1, 64, 830
- Mount Hope Bay, Mass. (*see* Fall River Harbor) 1, 116, 903
- Mount Pleasant shore, Charleston, S. C., improvement at..... 1, 247; II, 1166
- Mud Lake, La. (*see* Mermentau River) 1, 323, 324; II, 1343
- Mud River, Ga., improvement of waterway via..... 1, 262; II, 1196
- Mud River, S. C. (*see* Savannah-Beaufort channel) 1, 251; II, 1177

- New Jersey-Staten Island channel:
 Improvement of i, 162; ii, 1012
 Removal of wreck in Arthur Kill i, 177; ii, 1038
- New London Harbor, Conn.:
 Defenses of i, 19, 670
 Improvement of i, 124, 923
- New Orleans and Northwestern Railway Company, bridge of i, 582
- New Orleans Harbor, La.:
 Defenses of i, 7, 30, 747
 Improvement of (*see* Mississippi River Commission) i, 578; *S.*, 3, 31
- Newport Harbor, R. I.:
 Defenses of i, 7, 18, 658
 Harbor lines i, 579, 912
 Improvement of i, 117, 904
 Removal of wreck i, 122, 911
- Newport River, N. C.:
 Improvement of Beaufort Harbor i, 231; ii, 1137
 Improvement of waterway between Beaufort and New River ... i, 232; ii, 1138
 Improvement of waterway between Newbern and Beaufort i, 231; ii, 1136
- New River, N. C.:
 Improvement of i, 233; ii, 1139
 Improvement of waterway to Beaufort i, 232; ii, 1138
- New Rochelle, N. Y. (*see* Echo Bay Harbor) i, 146
- New Shoreham, Block Island, R. I.:
 Construction of harbor of refuge i, 120, 908
 Improvement of Great Salt Lake Pond i, 121, 909
- Newtown Creek, N. Y., improvement of i, 145, 960
- New Whatcom Harbor, Wash., improvement of i, 573; iii, 2429
- New York Central and Hudson River Railroad Company:
 Bridge of, across Chaumont River, N. Y. i, 590
 Bridge of, across Overpeck Creek, N. Y. i, 587
 Bridge of, across Peekskill Bay, N. Y. i, 588
 Bridge of, across Rondout Creek, N. Y. i, 586
- New York Harbor, N. Y.:
 Ambrose Channel, improvement of i, 146, 969
 Arthur Kill, improvement of i, 162; ii, 1012
 Arthur Kill, removal of wreck i, 177; ii, 1038
 Atlantic Basin, Buttermilk Channel, Brooklyn, harbor lines i, 579, 983
 Bay Ridge Channel, improvement of i, 148, 974
 Bayside Channel, improvement of i, 146, 969
 Bowery Bay, East River at Steinway, harbor lines i, 579, 964
 Bronx River, improvement of i, 154; ii, 998
 Bronx River, removal of wreck i, 178; ii, 1039
 Brooklyn, harbor lines in Buttermilk Channel at Atlantic Basin ... i, 579, 983
 Brooklyn, harbor lines at Cob Dock, navy-yard, East River i, 579, 966
 Buttermilk Channel, harbor lines at Atlantic Basin i, 579, 983
 Buttermilk Channel, improvement of i, 149, 976
 Cob Dock, East River, Brooklyn, harbor lines i, 579, 966
 Coney Island Creek, alteration of West End Bridge i, 590
 Defenses of i, 7, 20, 679
 Dutch Kills Creek, bridge across i, 587
 East (Ambrose) Channel, improvement of i, 146, 969
 East Chester Creek, improvement of i, 154, 155; ii, 999
 East River, harbor lines in Bowery Bay at Steinway i, 579, 964
 East River, harbor lines at Cob Dock, Brooklyn navy-yard i, 579, 966
 East River, improvement of i, 143, 957
 Ellis Island, harbor lines i, 579, 988
 Flushing Bay, improvement of i, 156, 158; ii, 1005
 Fort Totten, Engineer Depot and engineer troops i, 42, 802, 807, 817
 Gedney Channel, improvement of i, 146, 969
 Governors Island, enlargement of i, 150, 978
 Governors Island, removal of wreck i, 151, 982
 Gowanus Bay, harbor lines in Buttermilk Channel at Atlantic Basin ... i, 579, 983
 Gowanus Bay, removal of wreck in Red Hook Channel i, 151, 982
 Gowanus Bay and Canal, improvement of i, 148, 974
 Gowanus Creek channel, improvement of i, 150, 977
 Harlem River, improvement of i, 144, 959
 Hell Gate, East River, improvement of i, 143, 957

North Fork, Kentucky River, Ky., bridge below Jackson.....	i, 589
North Fork, Skagit River, Wash. (<i>see</i> Puget Sound).....	i, 565; iii, 2414
North Landing River, Va. and N. C., improvement of waterway via.....	i, 224; ii, 1122
North Menominee Canal, Milwaukee, Wis., bridge across.....	i, 588
North (Tolomato) River, Fla. (<i>see</i> St. Augustine Harbor).....	i, 269; ii, 1208
North River, N. C., improvement of waterway via.....	i, 224; ii, 1122
North River, Wash. (<i>see</i> Willapa River).....	i, 562; iii, 2409
North Tonawanda, N. Y. (<i>see</i> Tonawanda).....	i, 512; iii, 2314
Norwalk Harbor, Conn., improvement of.....	i, 137, 940
Noxubee River, Miss., improvement of.....	i, 301; ii, 1304

O.

Oak Creek, Wis. (<i>see</i> South Milwaukee Harbor).....	i, 447; iii, 2070
Oakland Harbor, Cal.:	
Defenses of San Francisco.....	i, 7, 34, 762
Improvement of.....	i, 527; iii, 2349
Oak Orchard Harbor, N. Y., improvement of.....	i, 513, 514; iii, 2321
Obion River, Tenn., improvement of.....	i, 386; ii, 1693
Occoquan Creek, Va., improvement of.....	i, 207; ii, 1090
Ocmulgee River, Ga., improvement of.....	i, 259; ii, 1191
Oconee River, Ga.:	
Bridge at Dublin.....	i, 584
Improvement of.....	i, 258; ii, 1189
Oconto Harbor, Wis., improvement of.....	i, 439; iii, 2046
Ocracoke Inlet, N. C., improvement of.....	i, 226; ii, 1129
Office of the Chief of Engineers, officers on duty in.....	i, 612
Officers, engineer, civilian assistants to.....	i, 38
Officers of the Corps of Engineers. <i>See</i> Corps of Engineers.	
Ogdensburg Harbor, N. Y., improvement of.....	i, 519; iii, 2335
Ohio River:	
Bridge at Mingo Junction.....	i, 582
Davis Island dam, Pa., operating and care.....	i, 407; iii, 1897
Falls at Louisville, Ky., improvement of, with plan for completing project.....	i, 421; iii, 1961, 1964
Final report on survey from Marietta, Ohio, to mouth of Big Miami River.....	i, 400; ii, 1867
Gauging (<i>see</i> Mississippi River Commission).....	i, 578; S., 3, 52
General improvement from Pittsburg to the mouth.....	i, 398; ii, 1839
Ice piers.....	i, 399; ii, 1842
Indiana Chute, Louisville, Ky., improvement of, with plan for completing project.....	i, 421; iii, 1961, 1964
Lock and Dam No. 37, construction of.....	i, 399; ii, 1864
Louisville and Portland Canal, Ky., enlargement of, with plan for completing project.....	i, 421; iii, 1961, 1964
Louisville and Portland Canal, Ky., operating and care.....	i, 424; iii, 1976
Movable dams, construction of.....	i, 410; iii, 1919
Pittsburg Harbor, Pa., improvement of.....	i, 405; iii, 1895
Snag boat, operation of.....	i, 400; ii, 1864
Okanogan River, Wash., improvement of.....	i, 574; iii, 2429, 2431
Okaw (Kaskaskia) River, Ill., bridge in Randolph County.....	i, 583
Okechobee Lake, Fla. (<i>see</i> Kissimmee River).....	i, 282; ii, 1217, 1225, 1239
Oklawaha River, Fla., improvement of.....	i, 268; ii, 1207
Olcott Harbor, N. Y., improvement of.....	i, 514; iii, 2322
Old Tampa Bay, Fla. (<i>see</i> Tampa Bay).....	i, 275; ii, 1219
Olympia Harbor, Wash., improvement of.....	i, 567; iii, 2416
Onset, Mass., bridge across Swifts River.....	i, 583
Ontario Lake:	
<i>See also</i> Northern and Northwestern Lakes.	
Water levels.....	i, 602; iv, 2763, 3032
Ontonagon Harbor, Mich., improvement of.....	i, 434; iii, 2028
Oostenaula River, Ga., improvement of.....	i, 291
Orange, Tex., furnishing of funds by citizens of, for Sabine Lake channel.....	i, 328; ii, 1347
Orange Mills Flats, St. Johns River, Fla., improvement at.....	i, 266; ii, 1205
Orange River, Fla., improvement of.....	i, 274; ii, 1218
Oranoken Creek, N. J., bridge at Beaver Dam.....	i, 586
Ordinance. <i>See</i> Fortifications.	

- Osage River, Mo.:
 Bridge across..... 1, 585
 Improvement by Missouri River Commission 1, 579; S., 181, 212
- Oswego Harbor, N. Y.:
 Improvement of 1, 517; III, 2330
 Water levels..... 1, 602; IV, 2763, 3032
- Otter Creek, Vt., improvement of..... 1, 93, 862
- Otter Tail Lake and River, Minn., survey of..... 1, 380; II, 1683
- Ouachita River, Ark. and La.:
 Final report on survey 1, 354; II, 1435
 Improvement of 1, 346; II, 1410
- Overpeck Creek, N. J.:
 Bridge at Little Ferry 1, 587
 Bridge at Ridgefield 1, 584
- P.**
- Pagan River, Va., improvement of 1, 221; II, 1116
- Pamlico River, N. C., improvement of 1, 228; II, 1131
- Pamlico Sound, N. C., improvement of waterway to Norfolk, Va 1, 223; II, 1120
- Pamunkey River, Va., improvement of 1, 215; II, 1099
- Parks, public:
 District of Columbia, improvement and care 1, 596; IV, 2717
 Gettysburg, Pa., bronze tablet to Abraham Lincoln 1, 596; IV, 2717
 Yellowstone National Park, improvement, etc..... 1, 604; IV, 3033
- Pascagoula River, Miss.:
 Bridge at Merrill 1, 585
 Improvement above mouth of Dog River 1, 303; II, 1309
 Improvement below mouth of Dog River 1, 301; II, 1305
- Pasig River, Manila, P. I., improvement of 1, 608; IV, 3055
- Pasquotank River, N. C.:
 Bridge across 1, 587
 Harbor lines at Elizabeth City 1, 579; II, 1127
 Improvement of waterway via..... 1, 223; II, 1120
- Passaic River, N. J.:
 Bridge at Newark 1, 586
 Improvement of 1, 161; II, 1010
- Pass a Loutre, Mississippi River, La.:
 Closing crevasse in 1, 314; II, 1322
 Constructing sill across..... 1, 315; II, 1323
- Passenger bridge across Potomac River at Washington, D. C., to replace
 Long Bridge 1, 592; IV, 2652
- Patapsco River, Md.:
 Defenses of Baltimore..... 1, 7, 22, 699
 Improvement of, and channel to Baltimore 1, 192; II, 1067
 Improvement of channel to Curtis Bay 1, 194; II, 1070
 Improvement of harbor at Southwest Baltimore (Spring Garden) . 1, 194; II, 1071
- Patchogue River, N. Y., improvement of 1, 160; II, 1009
- Patuxent River, Md., improvement of 1, 206; II, 1088
- Pawcatuck River, R. I. and Conn., improvement of 1, 123, 921
- Pawpaw River, Mich.:
 Alteration of bridges near Benton Harbor 1, 590, 591
 Improvement of St. Joseph Harbor 1, 460; III, 2141
- Pawtucket River, R. I.:
 Bridge at India Point, Providence 1, 587
 Improvement of 1, 114, 899
- Peace Creek, Fla. (*see* Charlotte Harbor) 1, 274; II, 1218
- Peacock's log landing, Chipola River, Fla., bridge at 1, 586
- Pearl Harbor, Hawaii:
 Defenses of..... 1, 7
 Improvement of 1, 534; III, 2361
- Pearl River, Miss.:
See also East Pearl River.
 Carthage to Jackson, improvement from 1, 309; II, 1315
 Edinburg to Carthage, improvement from 1, 309; II, 1316
 Rockport, improvement below 1, 308; II, 1314
- Pedee rivers, S. C.:
 Improvement 1, 237, 238; II, 1151
 Improvement of Little Pedee 1, 239; II, 1152

- Peekskill Bay and Harbor, N. Y.:
 Improvement of harbor i, 141, 142, 956
 Reconstruction of bridge 1, 588
- Pend Oreille River, Wash., improvement of i, 574; iii, 2430, 2431
- Pennsylvania Railroad Company:
See also Baltimore and Potomac Railroad.
 Bridge of, across Monongahela River at Try street, Pittsburg, Pa 1, 584
 Bridge of, across Monongahela River at Port Perry, Pa 1, 589
- Penobscot River, Me.:
 Defenses of i, 7, 14, 621
 Improvement of i, 68, 834
 Improvement of Bucksport Harbor i, 70, 836
- Pensacola Harbor, Fla.:
 Defenses of i, 7, 28, 735
 Improvement of i, 288; ii, 1267
- Pentwater Harbor, Mich., improvement of i, 468, 469; iii, 2166
- Pequonnock River, Conn. (*see* Bridgeport Harbor) i, 133, 937
- Pere Marquette Lake, Mich. (*see* Ludington Harbor) i, 470; iii, 2168
- Pere Marquette Railroad Company:
 Bridge of, across Grand River at Grand Rapids, Mich. 1, 590
 Bridge of, across Kalamazoo River at Allegan, Mich. 1, 585
 Bridges of, across Pawpaw River, near Benton Harbor, Mich. 1, 591
- Permanent appropriations for certain river and harbor works 1, 61
- Perry, La., bridge across Bayou Vermilion 1, 586
- Persons, private, improvement of navigable waters by i, 61; iv, 2567
- Perth Amboy, N. J.:
 Bridge across Raritan River 1, 589
 Bridge across Woodbridge Creek 1, 583
- Petaluma Creek, Cal., improvement of i, 532; iii, 2358
- Petoskey Harbor, Mich., improvement of i, 476; iii, 2180
- Philadelphia, Pa.:
 Bridge across Schuylkill River at Passyunk avenue 1, 586
 Defenses of Delaware River i, 7, 21, 694
 Harbor lines in Delaware River at League Island navy-yard i, 579; ii, 1041
 Improvement of Delaware River at i, 172; ii, 1025
 Removal of wreck in Delaware River at Tacony i, 178; ii, 1040
 Removal of wrecks in Schuylkill River i, 190; ii, 1063
- Philippine Islands:
 Defenses of Manila i, 7
 Military reconnaissances and explorations, and improvement of Manila
 Harbor and Pasig River i, 605, 606, 608; iv, 3050, 3055
- Phillips, W. K. (steamer), removal of wreck of i, 392; ii, 1706
- Piankatank River, Va., removal of wreck i, 218; ii, 1108
- Pierce County, Wash., bridge across Puyallup River in 1, 584
- Pierhead lines. *See* Harbor lines.
- Pierre, S. Dak. (*see* Missouri River) i, 382; ii, 1687
- Pierre, Fort, S. Dak. (*see* Missouri River) i, 382; ii, 1687
- Pigeon Bayous, La., improvement of i, 319; ii, 1334
- Pike Creek, Wis. (*see* Kenosha Harbor) i, 448; iii, 2073
- Pine Island Sound, Fla. (*see* Charlotte Harbor) i, 274; ii, 1218
- Pine Lake and River (Charlevoix County), Mich. (*see* Charlevoix Harbor) i, 474; iii, 2178
- Pine River (St. Clair County), Mich., improvement of i, 484; iii, 2194
- Pine River, Minn.:
 Construction of reservoir dam i, 374; ii, 1672
 Operating and care of reservoir dam i, 375; ii, 1675
- Pinole Point, Cal. (*see* San Pablo Bay) 1, 527
- Pittsburg and Mansfield Railroad Company, bridge of 1, 581
- Pittsburg Harbor, Pa.:
 Bridge across Monongahela River at Ferry street 1, 581
 Bridge across Monongahela River at Try street 1, 584
 Harbor lines in Monongahela River from Homestead Bridge to McKeesport i, 579; iii, 1912
 Improvement of i, 405; iii, 1895
 Operating and care of Davis Island dam, Ohio River i, 407; iii, 1897
- Plaquemine Bayou, La., improvement of i, 319; ii, 1334
- Plattsburg Harbor, N. Y., improvement of i, 93, 863
- Plattsmouth, Nebr., bridge across Missouri River 1, 586

Potomac River:

- See also* Washington, D. C.
 Aqueduct Bridge, Washington, D. C., repair of i, 591; iv, 2651
 Defenses of Washington, D. C. i, 7, 23, 704
 Highway bridge at Washington, D. C., to replace Long Bridge .. i, 592; iv, 2652
 Improvement at Washington, D. C. i, 203; ii, 1081
 Improvement below Washington, D. C. i, 205; ii, 1085
 Improvement of Eastern Branch (Anacostia River)..... i, 206; ii, 1087
 Memorial Bridge, Washington, D. C. i, 591; iv, 2652
 Railroad bridge at Washington, D. C., to replace Long Bridge..... i, 582
 Powow River, Mass., improvement of i, 85, 854
 Preliminary examinations of rivers and harbors, required to be made by act
 of 1902 i, 62
 Printing Office, Government, Washington, D. C.:
 Construction of new building for..... i, 611; iv, 3065
 Telegraph line..... i, 596; iv, 2717
 Private corporations, improvement of navigable waters by..... i, 61; iv, 2567
 Projects. *See* Rivers and harbors.
 Providence Harbor and River, R. I.:
 Bridge at India Point, Pawtucket River..... i, 587
 Improvement of..... i, 115, 900
 Improvement of Pawtucket River..... i, 114, 899
 Removal of Green Jacket Shoal..... i, 115, 116, 902
 Provincetown Harbor, Mass., improvement of i, 106, 107, 884
 Public buildings and grounds, District of Columbia..... i, 596; iv, 2717
 Public parks. *See* Parks.
 Puget Sound, Wash.:
 Bridge at Fremont, across waterway to lakes Union and Washington .. i, 588
 Bridge at Fremont avenue, Seattle, across waterway to lakes Union and
 Washington i, 589
 Defenses of..... i, 7, 36, 784
 Improvement of, and tributaries..... i, 565; iii, 2414
 Improvement of waterway to lakes Union and Washington, with esti-
 mate of cost of increased dimensions i, 568; iii, 2417, 2419
 Purification of water supply of Washington, D. C. i, 596; iv, 2712
 Put in Bay, Lake Erie, removal of wreck near i, 506; iii, 2293
 Puyallup River, Wash.:
 Bridge in Pierce County i, 584
 Improvement of (*see* Puget Sound)..... i, 565; iii, 2414
 Improvement of Tacoma Harbor..... i, 568; iii, 2417

Q.

- Queenstown Harbor, Md., improvement of..... i, 195; ii, 1072
 Quincy, Ill.:
 Bridge across Mississippi River..... i, 583
 Improvement of Mississippi River at i, 370; ii, 1618
 Quincy, Mass., bridge across Weymouth Fore River i, 584
 Quinnipiac River, New Haven, Conn., improvement of i, 128, 930
 Quitman County, Miss., bridge across Coldwater River..... i, 585

R.

- Raccoon Creek, N. J., improvement of..... i, 184; ii, 1053
 Racine Harbor, Wis., improvement of i, 447; iii, 2071
 Rafts, rules governing running of, on certain streams i, 580
 Railway, boat, Columbia River, Oreg. and Wash..... i, 546; iii, 2376
 Railway bridge across Potomac River at Washington, D. C., to replace Long
 Bridge..... i, 582
 Raisin River, Mich. (*see* Monroe Harbor) i, 481, 482; iii, 2247
 Ranald (steamship), removal of wreck of i, 190; ii, 1062
 Rancocas River, N. J.:
 Improvement of..... i, 179; ii, 1046
 Removal of wreck..... i, 190; ii, 1063
 Randolph County, Ill., bridge across Kaskaskia River in i, 583
 Range and position finders..... i, 11, 38
 Rappahannock River, Va., improvement of i, 211; ii, 1093

Rivers and harbors—Continued.

Rules governing running of loose logs, steamboats, and rafts on certain streams.....	i, 580
Status of works	i, 61
Roads:	
Fort Washakie, Wyo., to Buffalo Fork, Snake River.....	i, 612; iv, 3075
In military divisions and departments.....	i, 605; iv, 3049
Yellowstone National Park	i, 604; iv, 3033
Roanoke River, N. C., improvement of	i, 225; ii, 1125
Rochambeau statue, Washington, D. C.....	i, 596; iv, 2717
Rockhall Harbor, Md., improvement of.....	i, 195; ii, 1071
Rockhaven, N. Dak., ice harbor (<i>see</i> Missouri River)	i, 385; ii, 1687
Rockland Harbor, Me., improvement of.....	i, 71, 837
Rockport, Mass.:	
Construction of harbor of refuge in Sandy Bay.....	i, 85, 854
Improvement of harbor.....	i, 87, 856
Rock River, Ill.:	
Construction of canal around	i, 455; iii, 2118
Operating and care of canal around.....	i, 372; ii, 1656
Rogers, Peter A. (canal boat), removal of wreck of.....	i, 190; ii, 1063
Romerly Marsh, Ga., improvement of waterway via.....	i, 262; ii, 1196
Rondout Creek and Harbor, N. Y.:	
Bridge near Kingston Station	i, 586
Improvement of harbor.....	i, 141, 955
Root River, Wis. (<i>see</i> Racine Harbor).....	i, 447; iii, 2071
Rostraver Township, Pa., bridge across Monongahela River.....	i, 582
Rouge River, Mich.:	
Bridge at Delray	i, 589
Improvement of	i, 481; iii, 2192
Rough River, Ky.:	
Improvement of	i, 428; iii, 1998
Operating and care of lock and dam.....	i, 428; iii, 1999
Rules and regulations:	
For navigation of canals, etc	i, 580
For opening of drawbridges.....	i, 581
For running of loose logs, steamboats, and rafts on certain streams	i, 580
Runyans Creek, N. C., bridge across.....	i, 584

S.

Sabine Lake, Pass, and River, Tex.:

Connection with Port Arthur Canal.....	i, 328; ii, 1347
Defenses of.....	i, 7, 30, 747
Improvement of mouth of river and of channel through lake	i, 328; ii, 1347
Improvement of river.....	i, 329; ii, 1348
Improvement of Sabine Pass Harbor.....	i, 330; ii, 1349
Sack rafts, rules governing running of, on certain streams	i, 580
Saco River, Me., improvement of	i, 77, 845
Sacramento River, Cal.:	
Bridge at Knights Landing.....	i, 586
Improvement of	i, 530; iii, 2355
Improvement of, by California Débris Commission	i, 577; iii, 2443
Sag Harbor, N. Y., improvement at	i, 156, 159
Saginaw Harbor and River, Mich.:	
Bridge at Genesee avenue, Saginaw.....	i, 589
Improvement of river.....	i, 478; iii, 2186
St. Augustine Harbor, Fla.:	
Defenses of.....	i, 26, 728
Improvement of	i, 269; ii, 1208
St. Clair Canal and River, Mich.:	
Improvement of	i, 491; iii, 2233
Improvement of channels in waters connecting the Great Lakes.	i, 485; iii, 2197
Operating and care of canal	i, 492; iii, 2234
Removal of wreck	i, 494; iii, 2244, 2245
Surveys, etc. (<i>see</i> Northern and Northwestern Lakes).....	i, 598; iv, 2763
St. Clair Terminal Railroad Company, bridge of.....	i, 582
St. Croix Lake and River, Wis. and Minn., improvement of.....	i, 376; ii, 1678

- St. Francis River, Ark. and Mo.:
 Gauging (*see* Mississippi River Commission) 1, 578; S., 3, 52
 Improvement of, in Arkansas 1, 363; II, 1588, 1590
 Improvement of, in Missouri 1, 365; II, 1591
- St. George Sound, Fla. (*see* Carrabelle bar and harbor) 1, 282; II, 1253
- St. Johns River, Fla.:
 Defenses of 1, 7, 26, 728
 Improvement between Jacksonville and the ocean 1, 265; II, 1201
 Improvement between Jacksonville and Palatka, including Orange Mills
 Flats 1, 266; II, 1205
 Improvement of Volusia Bar, and between Volusia Bar and Lake
 Monroe 1, 267; II, 1206
- St. Joseph Harbor and River, Mich.:
 Improvement of harbor 1, 460; III, 2141
 Improvement of river 1, 460, 461; III, 2143
- St. Lawrence River, N. Y.:
 Alexandria Bay, harbor lines 1, 579; III, 2338
 Cape Vincent Harbor, improvement of 1, 518; III, 2332
 Defenses of 1, 7, 33, 759
 Long Sault Island, improvement at head of 1, 520; III, 2337
 Ogdensburg Harbor, improvement of 1, 519; III, 2335
 Ogdensburg to foot of Lake Ontario, removal of shoals 1, 519; III, 2334
- St. Louis Bay and River, Minn. and Wis. (*see* Duluth Harbor) 1, 430; III, 2005
- St. Louis Harbor, Mo., improvement of 1, 368; II, 1604
- St. Louis, Kansas City and Colorado Railroad Company:
 Bridge of, across Gasconade River 1, 583
 Bridge of, across Osage River 1, 585
- St. Louis Valley Railway, bridge of 1, 583
- St. Marys River and St. Marys Falls Canal, Mich.:
 Commercial statistics 1, 488; III, 2217
 Improvement of channels in waters connecting the Great Lakes 1, 485; III, 2197
 Improvement of Hay Lake and Neebish channels 1, 489; III, 2228
 Improvement of river at the falls 1, 487; III, 2201
 Operating and care of canal 1, 488; III, 2215
 Removal of wreck 1, 494; III, 2244
 Surveys, etc. (*see* Northern and Northwestern Lakes) 1, 598; IV, 2763
 Survey of, final report on 1, 494
- St. Peter (steamer), removal of wreck of 1, 237
- St. Peters River, Minn. *See* Minnesota River.
- Sakonnet River, R. I., increasing width and depth of draw opening in Stone
 Bridge 1, 113, 898
- Saline River, Ark., survey of (*see* Ouachita and Black rivers) 1, 354; II, 1435
- Salisbury, Mass., bridge across Merrimac River 1, 586
- Salmon Bay, Wash., improvement of waterway via 1, 568; III, 2417, 2419
- Sampit River (Georgetown Harbor), S. C. (*see* Winyah Bay) 1, 241; II, 1154
- San Antonio estuary, Cal. (*see* Oakland Harbor) 1, 527; III, 2349
- Sandbeach, Mich.:
 Improvement of harbor of refuge 1, 480; III, 2189
 Water levels 1, 602; IV, 2763, 3032
- San Diego Harbor, Cal.:
 Defenses of 1, 7, 34, 760
 Improvement of 1, 521; III, 2341
- Sandusky Harbor, Ohio, improvement of 1, 496; III, 2257
- Sandwich Islands. *See* Hawaiian Islands.
- Sandy Bay, Cape Ann, Mass.:
 Construction of harbor of refuge 1, 85, 854
 Improvement of Rockport Harbor 1, 87, 856
- Sandy Lake, Minn.:
 Construction of reservoir dam 1, 374; II, 1672
 Operating and care of reservoir dam 1, 375; II, 1675
- Sandy Point light-house, Chesapeake Bay, removal of wreck off 1, 203; II, 1080
- San Francisco Bay and Harbor, Cal.:
 Defenses of 1, 7, 34, 762
 Improvement of channel between Strait of Karquines and the Golden
 Gate 1, 527
 Improvement of harbor 1, 526; III, 2348
 Improvement of Oakland Harbor 1, 527; III, 2349

- Sanitary District of Chicago, Ill.:
 Bridge of, across South Branch, Chicago River, at Loomis Street 1, 589
 Connection of Chicago River with drainage canal 1, 580
 San Jacinto River, Tex. (*see* Galveston ship channel) 1, 334; II, 1374
 San Joaquin River, Cal.:
 Improvement of 1, 528; III, 2352
 Improvement of, by California Débris Commission 1, 577; III, 2443
 Improvement of Stockton and Mormon channels 1, 529
 San Juan, P. R., defenses of 1, 7, 37, 791
 San Leandro Bay, Cal. (*see* Oakland Harbor) 1, 527; III, 2349
 San Luis Obispo Harbor, Cal., improvement of 1, 524; III, 2345
 San Pablo Bay, Cal., improvement of 1, 527
 San Pedro Bay and Harbor, Cal.:
 Construction of deep-water harbor 1, 522; III, 2342
 Improvement of Wilmington inner harbor 1, 523; III, 2344
 Removal of wreck in inner harbor 1, 525; III, 2346
 Santee River, S. C., improvement of 1, 242; II, 1160
 Sarasota Bay, Fla., improvement of 1, 275; II, 1218
 Saugatuck River, Conn., improvement of 1, 136, 939
 Saugatuck Harbor, Mich., improvement of 1, 462; III, 2149
 Saugerties Harbor, N. Y., improvement of 1, 141, 954
 Saugus River, Mass. (*see* Lynn Harbor) 1, 95, 867
 Sauk River, Wis. (*see* Port Washington Harbor) 1, 445; III, 2065
 Sault Ste. Marie, Mich.:
See also St. Marys River.
 Commerce passing canals at 1, 488; III, 2217
 Water levels 1, 602; IV, 2763, 3032
 Sausal Creek, Cal. (*see* Oakland Harbor) 1, 527; III, 2349
 Savannah Harbor and River, Ga.:
 Bridge below Augusta 1, 591
 Defenses of 1, 7, 26, 727
 Improvement of harbor 1, 251; II, 1177
 Improvement of river above Augusta 1, 255; II, 1184
 Improvement of river between Augusta and Savannah 1, 253; II, 1182
 Improvement of waterway to Beaufort, S. C. (*see* Savannah Harbor) 1, 251; II, 1177
 Improvement of waterway to Fernandina, Fla. 1, 262; II, 1196
 Removal of wreck at Twigg's Bar 1, 264; II, 1200
 Sayville, N. Y., improvement of Browns Creek 1, 159; II, 1008
 School of Application, Engineer 1, 39, 796
 Schuylkill River, Pa.:
 Bridge at Passyunk avenue, Philadelphia 1, 586
 Removal of wrecks 1, 190; II, 1063
 Scituate Harbor, Mass., improvement of 1, 104, 880
 Scuppernon River, N. C., improvement of 1, 226
 Seacoast defenses. *See* Fortifications.
 Searchlights 1, 14, 38
 Seattle, Wash.:
 Bridge across Canal Waterway 1, 584
 Bridge across Duwamish River near 1, 584, 585
 Bridge across East Waterway 1, 590
 Bridge at Fremont across route of Puget Sound-Lake Washington
 waterway 1, 588
 Bridge of Seattle Electric Company across Lake Union 1, 584, 585
 Bridge of city of, across Lake Union at Hester avenue 1, 589
 Waterway from Puget Sound to Lake Washington, improvement of, with
 estimate of cost of increased dimensions 1, 568; III, 2417, 2419
 Seattle and Montana Railroad Company, bridge of 1, 585
 Seattle and San Francisco Railroad and Navigation Company, bridge of 1, 590
 Seattle Electric Company:
 Bridges of, across Duwamish River, near Seattle, and across Lake Union,
 at Seattle, Wash. 1, 584
 Bridge of, across route of Puget Sound-Lake Washington Canal at Seattle,
 Wash. 1, 589
 Seattle-Tacoma Railway Company, bridge of 1, 584
 Seattle-Tacoma Interurban Railway, bridges of 1, 584
 Sea walls 1, 12, 38
 Sebawaing River, Mich., improvement of 1, 479; III, 2187
 Secretary Creek (Warwick River), Md., improvement of 1, 195, 198; II, 1075

- South Edisto River, S. C., waterway via i, 249; ii, 1171
- Southern Branch, Elizabeth River, Va.:
 Improvement of Norfolk Harbor and its approaches i, 219; ii, 1111
 Improvement of waterway to Albemarle Sound, via Currituck
 Sound i, 224; ii, 1122
 Improvement of waterway to sounds of North Carolina, via Pasquotank
 River i, 223; ii, 1120
 Removal of wrecks in i, 226; ii, 1126
- Southern Illinois and Missouri Bridge Company, bridge of i, 582
- Southern Missouri and Arkansas Railroad Company, bridge of i, 582
- Southern Pacific Company:
 Bridge of, across Bayou Vermilion, La. i, 584
 Bridge of, across Napa River, Cal. i, 586
 Bridge of, across Sacramento River, Cal. i, 586
- South Haven Harbor, Mich., improvement of i, 462; iii, 2146
- South Kingston, R. I.:
 Construction of Point Judith harbor of refuge i, 119, 906
 Improvement of entrance to Point Judith Pond i, 120, 907
 Removal of wreck in Point Judith Harbor i, 122, 912
- South Mills, N. C., removal of wreck in Turners Cut i, 226; ii, 1126
- South Milwaukee Harbor, Wis., improvement of i, 447; iii, 2070
- South Norwalk Harbor, Conn. (*see* Norwalk) i, 137, 940
- South Pass, Mississippi River, La., maintenance of channel i, 316; ii, 1324
- Southport Harbor, Conn., improvement of i, 137, 138, 943
- South River, N. J., improvement of i, 165, 167; ii, 1019
- Southwest Baltimore, Md., improvement of harbor of i, 194; ii, 1071
- Southwest Pass, Mississippi River, La., improvement of i, 315; ii, 1173, 1323
- Sparrows Point, Md., bridge across Bear Creek i, 588
- Springdale, Pa., construction of lock and dam in Allegheny River, with
 revised estimate of cost i, 408; iii, 1900, 1901
- Spring Garden, Baltimore, Md., improvement of harbor at i, 194; ii, 1071
- Spuytten Duyvil Creek, N. Y. (*see* Harlem River) i, 144, 959
- Squan (Manasquan) River, N. J., improvement of i, 171; ii, 1024
- Stage Harbor, Mass. (*see* Chatham Harbor) i, 107, 883
- Stamford Harbor, Conn., improvement of i, 137, 138, 943
- Staten Island-New Jersey Channel, N. Y. and N. J. i, 162; ii, 1012
- Staten Island Sound (Arthur Kill), N. Y. and N. J.:
 Improvement of i, 162; ii, 1012
 Removal of wreck i, 177; ii, 1038
- Statistics of commerce, Sault Ste. Marie canals, Mich. i, 488; iii, 2217
- Statues, memorials, etc.:
 In public grounds, Washington, D. C. i, 596; iv, 2717
 Memorial Bridge, Washington, D. C. i, 591; iv, 2652
 Tablet to Abraham Lincoln, Gettysburg Park, Pa. i, 596; iv, 2717
- Steamboats:
See also Dredge and Snag boats, and Wrecks.
 Rules governing running of, on certain streams i, 580
- Steinway, N. Y., harbor lines in Bowery Bay, East River i, 579, 964
- Stilaguamish River, Wash. (*see* Puget Sound) i, 565; iii, 2414
- Stillwater Harbor, Minn. (*see* St. Croix River) i, 376; ii, 1678
- Stockbridge Landing, Lake Winnebago, Wis. (*see* Fox River) i, 449; iii, 2077
- Stockton channel, San Joaquin River, Cal., improvement of i, 529
- Stone Bridge, Sakonnet River, R. I., alteration of i, 113, 898
- Stone Horse Shoal, Mass., removal of wreck on i, 122, 912
- Sturgeon Bay and Lake Michigan Canal, Wis.:
 Improvement of, including harbor of refuge i, 441; iii, 2049
 Operating and care i, 442; iii, 2054
- Subig Bay, Philippine Islands, defenses of i, 7
- Submarine mines i, 6, 7, 13, 38
- Sullivan Falls Harbor, Me., improvement of i, 65, 830
- Sullivan Island shore, Charleston, S. C., improvement at i, 247; ii, 1166
- Sullivan River, Me., improvement of Sullivan Falls Harbor i, 65, 830
- Sulphur River, Ark. and Tex. (*see* Red River) i, 343; ii, 1405
- Sunflower (barge), removal of wreck of i, 190; ii, 1063
- Sunken craft. *See* Wrecks.
- Superior Bay and Harbor, Wis., improvement of i, 430; iii, 2005

Technical details of engineering methods—Continued.

- Oil as a road builder iii, 2561
- Waterproofing, defenses of coast of Maine iii, 2451
- Waterproofing, defenses of Mobile and Mississippi Sound iii, 2467
- Telegraph line, Government, Washington, D. C. i, 596; iv, 2717
- Tennessee River:
 - Chattanooga, Tenn., improvement above i, 393; ii, 1709, 1711
 - Chattanooga, Tenn., to Riverton, Ala., improvement from i, 393; ii, 1709, 1712
 - Gauging (*see* Mississippi River Commission) i, 578; S., 3, 52
 - Muscle Shoals Canal, Ala., operating and care i, 395; ii, 1726
 - Riverton, Ala., improvement below i, 395; ii, 1709, 1715
 - Survey from Scott Point, Tenn., to Lock A, at head of Muscle Shoals Canal i, 398; ii, 1743
- Tensas River, La.:
 - Improvement of i, 347, 349; ii, 1418
 - Survey of (*see* Ouachita and Black rivers) i, 354; ii, 1435
- Terraceia Cut-off, Fla. (*see* Manatee River) i, 278, 279; ii, 1223
- Texas:
 - Dredge and snag boat for certain works in State of i, 337; ii, 1379
 - Reconnaissances and explorations in department of i, 605, 610; iv, 3061
 - Removal of water hyacinths from waters in State of i, 272, 327
- Texas and Pacific Railway Company, bridge of i, 581
- Texas City, Tex., improvement of channel to Galveston i, 334; ii, 1372
- Thames River, Conn.:
 - Improvement of i, 125, 924
 - Improvement of New London Harbor i, 124, 923
- Thebes, Ill., bridge across Mississippi River i, 582
- The Board of Engineers i, 6, 7, 615
- Three-mile Rapids, Columbia River, Oreg. and Wash., improvement at i, 546; iii, 2376
- Thunder Bay River, Mich., improvement of Alpena Harbor i, 477; iii, 2185
- Tickfaw River, La., improvement of, including tributaries i, 311, 312; ii, 1319
- Tillamook Bay and Bar, Oreg., improvement of i, 543; iii, 2373
- Timber, rules governing running of loose, on certain streams i, 580
- Tiverton, R. I., alteration of Stone Bridge across Sakonnet River i, 113, 898
- Tohopekaliga Lake, Fla. (*see* Kissimmee River) i, 274, 282; ii, 1217, 1225, 1239
- Toledo Harbor, Ohio:
 - Bridge across Maumee River i, 588
 - Improvement of i, 494; iii, 2249
- Tolomato River, Fla. (*see* St. Augustine Harbor) i, 269; ii, 1208
- Tombigbee River, Ala. and Miss.:
 - Columbus to Fulton, Miss., improvement from i, 299; ii, 1289, 1298
 - Demopolis, Ala., improvement below i, 297; ii, 1289, 1296
 - Demopolis, Ala., to Columbus, Miss., improvement from i, 298; ii, 1289, 1297
 - Fulton to Walkers Bridge, Miss., improvement from i, 300; ii, 1289, 1299
- Tonawanda Harbor, N. Y., improvement of i, 512; iii, 2314
- Tongue Point, Columbia River, Oreg., improvement below i, 556; iii, 2398
- Tonnage, Sault Ste. Marie canals, Mich. i, 488; iii, 2217
- Torpedoes i, 6, 7, 13, 38
- Totten, Fort, N. Y., Engineer Depot and engineer troops i, 42, 802, 807, 817
- Town Creek, Brunswick County, N. C., improvement of i, 236; ii, 1147
- Town River, Mass., improvement of i, 102, 878
- Trail Creek, Ind.:
 - Bridge of Laporte County at Michigan City i, 584
 - Bridge of Michigan Central Railroad Company at Michigan City i, 587
 - Improvement of Michigan City inner harbor i, 457; iii, 2137
 - Improvement of Michigan City outer harbor i, 458; iii, 2137
- Traverse Lake, Minn., survey of i, 381; ii, 1684
- Trent River, N. C.:
 - Bridge near Pollokville i, 583
 - Improvement of i, 229, 230; ii, 1134
- Trinity River, Tex.:
 - Bridge in Liberty County i, 583
 - Improvement of i, 336, 337, 338; ii, 1378, 1379, 1382
- Troops:
 - Battalions of Engineers i, 38, 40, 42, 44, 607, 802, 811, 814, 818; iv, 3054
 - Engineer equipment of i, 38, 44, 811, 814, 818
 - Service of officers of the Corps of Engineers abroad and in the field, with i, 45

- Warrior River, Ala.:
 Improvement above Tuscaloosa I, 295; II, 1285
 Improvement below Tuscaloosa I, 296; II, 1289, 1290
 Operating and care of locks and dams above Tuscaloosa I, 300; II, 1300
 Revised estimates of cost of locks and dams above and below Tuscaloosa III, 1288, 1293
- Warroad Harbor and River, Minn., improvement of I, 379; II, 1682
- Warwick River, Md., improvement of I, 195, 198; II, 1075
- Washakie, Fort, Wyo., road to Buffalo Fork, Snake River I, 612; IV, 3075
- Washington, D. C.:
 Aqueduct Bridge across Potomac River, repair of I, 591; IV, 2651
 Aqueduct, Dalecarlia Reservoir I, 593; IV, 2691
 Aqueduct, filtration plant I, 596; IV, 2712
 Aqueduct, increasing water supply I, 594; IV, 2706
 Aqueduct, maintenance and repair I, 593; IV, 2691
 Aqueduct Tunnel and Howard University Reservoir I, 594; IV, 2706
 Barracks I, 39, 793
 Battalion of Engineers, Third I, 40, 802
 Defenses of I, 7, 23, 704
 Engineer Depot I, 41, 42, 807
 Engineer School of Application, U. S. Army I, 39, 796
 Executive Mansion I, 596; IV, 2717
 Government Printing Office, new building for I, 611; IV, 3065
 Highway bridge across Potomac River to replace Long Bridge I, 592; IV, 2652
 Improvement of Anacostia River at I, 206; II, 1087
 Improvement of Potomac River at I, 203; II, 1081
 Improvement of Potomac River below I, 205; II, 1085
 Memorial Bridge across Potomac River I, 591; IV, 2652
 Public buildings and grounds, and Washington Monument I, 596; IV, 2717
 Railroad bridge across Potomac River to replace Long Bridge I, 582
 Statues and memorials I, 596; IV, 2717
- Washington and Oregon Railway Company, bridge of I, 585
- Washington and Plymouth Railroad Company, bridge of I, 584
- Washington Lake, Wash.:
 Bridge at Fremont across waterway to Puget Sound I, 588
 Bridge at Fremont avenue, Seattle, across waterway to Puget Sound I, 589
 Improvement of waterway to Puget Sound, with estimate of cost of increased dimensions I, 568; III, 2417, 2419
- Washington Monument, D. C. I, 596; IV, 2717
- Washington, State of, contract with R. B. Lehuman (*see* Tacoma Harbor) I, 568; III, 2417
- Washita (Ouachita) River, Ark. and La.:
 Final report on survey I, 354; II, 1435
 Improvement of I, 346; II, 1410
- Water craft:
See also Dredge and Snag boats, and Wrecks.
 Rules governing running of steamboats on certain streams I, 580
- Wateree River, S. C., improvement of I, 242, 243; II, 1162
- Water hyacinths:
 Removal of, from Florida waters I, 272; II, 1215
 Removal of, from Louisiana waters I, 327; II, 1347
 Removal of, from Texas waters I, 272, 327
- Water-level observations:
 Columbia River, Oreg. and Wash I, 561; III, 2408
 Michigan Lake, variations in surface level on east shore I, 457
 Mississippi River and principal tributaries I, 578; S., 3, 52
 Northern and Northwestern Lakes I, 601, 602; IV, 2763
- Waters, navigable. *See* Bridges, Rivers and harbors, and Wrecks.
- Water supply, Washington, D. C. *See* Washington, D. C.
- Waterways (*see also* Canals):
 Beaufort, N. C., to Newbern I, 231; II, 1136
 Beaufort, N. C., to New River I, 232; II, 1138
 Charleston to Beaufort, S. C., improvement of I, 249; II, 1171
 Charleston to Beaufort, S. C., sunken logs I, 251; II, 1173
 Charleston to McClellanville, S. C. I, 246; II, 1166
 Chincoteague Bay, Va., to Delaware Bay, Del I, 188; II, 1060
 Galveston to Houston, Tex. I, 334; II, 1374
 Keweenaw Bay to Lake Superior, Mich I, 435, 436; III, 2030

- Winnibigoshish Lake, Minn.:
 Construction of reservoir dam i, 374; ii, 1672
 Operating and care of reservoir dam i, 375; ii, 1675
 Winslow, Richard (barge), removal of wreck of, in Straits of Mackinac. i, 494; iii, 2244
 Winthrop, Mass.:
 Bridge across Crystal Cove i, 586
 Roadway at i, 651
 Winthrop Cove, New London, Conn. (*see* New London) i, 124, 923
 Winyah Bay, S. C., improvement of i, 241; ii, 1154
 Wisconsin Entrance, Superior Harbor, Wis., improvement of i, 430; iii, 2005
 Wisconsin River, Wis.:
 Bridge at Kilbourn City i, 589
 Bridge at Merrimac i, 585
 Improvement of (*see* Fox River) i, 449; iii, 2077
 Withlacoochee River, Fla., improvement of i, 278, 280; ii, 1223
 Wolf River, Memphis, Tenn. (*see* Mississippi River Commission) i, 578; S., 3, 31
 Wolf (Ahnapee) River, Wis. (*see* Ahnapee Harbor) i, 442; iii, 2057
 Wolf River (tributary of the Fox), Wis. (*see* Fox River) i, 449; iii, 2077
 Woodbridge, N. J., bridge across Woodbridge Creek i, 583
 Woodbridge Creek, N. J.:
 Bridge between Perth Amboy and Woodbridge i, 583
 Improvement of i, 164
 Woods Hole channel, Mass., improvement of i, 111, 894
 Wrecks, etc., removal of i, 61
 Absecon light, N. J. i, 190; ii, 1062
 Arthur Kill, N. Y. and N. J. i, 177; ii, 1038
 Ashtabula Harbor, Ohio i, 506; iii, 2293
 Atlantic Ocean, off Absecon light, N. J. i, 190; ii, 1062
 Beaufort-Charleston, S. C., waterway, sunken logs i, 251; ii, 1173
 Berkley, Va. i, 226; ii, 1126
 Biddeford Pool Harbor, Me. i, 95, 865
 Bronx River, N. Y. i, 178; ii, 1039
 Buffalo Bayou, Tex. i, 342; ii, 1391
 Cambridge Harbor, Md. i, 203; ii, 1080
 Cape Fear River, N. C., Northeast Branch i, 237
 Carters Creek, Va. i, 218; ii, 1108
 Charleston-Beaufort, S. C., waterway, sunken logs i, 251; ii, 1173
 Chatham, Mass. i, 122, 911
 Chesapeake Bay i, 203; ii, 1080
 Chester River, Pa. i, 190; ii, 1063
 Choptank River, Md., Cambridge Harbor i, 203 ii, 1080
 Cumberland River i, 392; ii, 1706
 Delaware Bay and River i, 178; ii, 1039, 1040
 Delaware Breakwater Harbor, Del. i, 178; ii, 1039
 Dennis Creek, N. J. i, 190; ii, 1063
 Dover Island, Cumberland River i, 392; ii, 1706
 Duck Creek (Smyrna River), Del. i, 190; ii, 1062
 Duluth Harbor, Minn. i, 438; iii, 2042
 Edgewater, N. J. i, 151, 982
 Elizabeth River, Va., Southern Branch i, 226; ii, 1126
 Erie Lake i, 506; iii, 2293, 2294
 Flint River, Ga. i, 293; ii, 1280
 Fourteen Foot Bank light-house, Delaware Bay i, 178; ii, 1040
 Galveston Bay and Harbor, Tex. i, 342; ii, 1390, 1391
 Governors Island, New York Harbor, N. Y. i, 151, 982
 Gowanus Bay, N. Y., Red Hook Channel i, 151, 982
 Green Run Inlet life-saving station i, 190; ii, 1063
 Hallsville, N. C. i, 237
 Hardings Beach, Chatham, Mass. i, 122, 911
 Hillsboro Bay, Fla. i, 281; ii, 1225
 Judith, Point, R. I., harbor at i, 122, 912
 Key West Harbor, Fla. i, 273; ii, 1216
 Kingston (Point Judith Harbor), R. I. i, 122, 912
 Little Creek, Del. i, 190; ii, 1063
 Mackinac Straits, Mich. i, 494; iii, 2244
 Mahon River, Del. i, 190; ii, 1063
 Main Ship Channel, New York Harbor, N. Y. i, 151, 982
 Mississippi River, above Missouri River i, 370; ii, 1609
 Mississippi River, below Missouri River i, 366; ii, 1593

Wrecks, etc., removal of—Continued.

Monomoy light, Mass., off	i, 122, 911, 912
Monroe Harbor, Mich.	i, 506; iii, 2294
Nauset Harbor, Mass.	i, 108, 886
Newark Bay	i, 177; ii, 1038
New Brunswick, N. J.	i, 177; ii, 1038
Newport Harbor, R. I.	i, 122, 911
New York Harbor, N. Y., Arthur Kill	i, 177; ii, 1038
New York Harbor, N. Y., Bronx River	i, 178; ii, 1039
New York Harbor, N. Y., Main Ship Channel	i, 151, 982
New York Harbor, N. Y., Governors Island	i, 151, 982
New York Harbor, N. Y., Red Hook Channel	i, 151, 982
Norfolk Harbor, Va., Southern Branch, Elizabeth River	i, 226; ii, 1126
Northeast River, N. C.	i, 237
Philadelphia, Pa., Delaware River at Tacony	i, 178; ii, 1040
Philadelphia, Pa., Schuylkill River	i, 190; ii, 1063
Piankatank River, Va.	i, 218; ii, 1108
Point Judith Harbor, R. I.	i, 122, 912
Pollock Rip light-ship, Mass., near	i, 122, 912
Put in Bay, Lake Erie	i, 506; iii, 2293
Rancocas River, N. J.	i, 190; ii, 1063
Raritan River, N. J.	i, 177; ii, 1038
Red Hook Channel, New York Harbor, N. Y.	i, 151, 982
St. Clair River, Mich.	i, 494; iii, 2244, 2245
St. Marys River, Mich.	i, 494; iii, 2244
Sandy Point light-house, Chesapeake Bay	i, 203; ii, 1080
San Pedro inner harbor, Cal.	i, 525; iii, 2346
Savannah River, Ga.	i, 264; ii, 1200
Schuylkill River, Pa.	i, 190; ii, 1063
Sewaren, N. J.	i, 177; ii, 1038
Smyrna River, Del.	i, 190; ii, 1062
Southern Branch, Elizabeth River, Va.	i, 226; ii, 1126
South Kingston (Point Judith Harbor), R. I.	i, 122, 912
South Mills, N. C.	i, 226; ii, 1126
Staten Island Sound (Arthur Kill), N. Y. and N. J.	i, 177; ii, 1038
Stone Horse Shoal, off Monomoy light, Mass.	i, 122, 912
Superior Lake, near Duluth Canal, Minn.	i, 438; iii, 2042
Tacony, Philadelphia, Pa.	i, 178; ii, 1040
Tampa, Fla.	i, 281; ii, 1225
Turners Cut, N. C.	i, 226; ii, 1126
Twiggs Bar, Savannah River, Ga.	i, 264; ii, 1200
Weehawken, N. J.	i, 151, 982
Wilmington inner harbor, Cal.	i, 525; iii, 2346
Wyandotte, Mich. (<i>see</i> Detroit River)	i, 492; iii, 2235

Y.

Yamhill River, Oreg.:

Improvement of	i, 552; iii, 2388
Operating and care of lock and dam	i, 554; iii, 2390
Yankton, S. Dak. (<i>see</i> Missouri River)	ii, 383; iii, 1687
Yaquina Bay, Oreg., improvement of	i, 541; iii, 2371
Yazoo and Mississippi Valley Railroad Company:	
Bridge of, across Coldwater River, Miss.	i, 585
Bridge of, across Yazoo River, Miss.	i, 586
Yazoo City, Miss., bridge across Yazoo River near	i, 586
Yazoo River, Miss.:	
Bridge near Yazoo City	i, 586
Improvement above mouth	i, 351; ii, 1429
Improvement of mouth, including Vicksburg Harbor	i, 350; ii, 1420
Yellow Mill Pond, Bridgeport, Conn. (<i>see</i> Bridgeport)	i, 133, 937
Yellowstone National Park	i, 604; iv, 3033
York River, Va., improvement of	i, 207; ii, 1089
Yuba River, Cal. (<i>see</i> Sacramento River and California Débris Commission)	i, 530, 577; iii, 2355, 2443

Zeus (canal boat), removal of wreck of i, 190; ii, 1062

ENG 1902



